6.0 Smallmouth Bass Age, Total Mercury and Coplanar PCB TEQs

This chapter graphically and statistically analysed smallmouth bass age in Reaches 1, 2, 3, 5 and 7. Smallmouth bass age was negatively statistically correlated with Reach, total mercury, and PCB TEQs for human/mammalian, bird and fish receptors.

6.1 Smallmouth Bass Age

Aging of smallmouth bass from Reaches 1, 2, 3, 5, and 7 was undertaken by the Central New England Fishery Resources Office of the US Fish and Wildlife Service in Nashua, New Hampshire. Appendix A contains the full text of the November, 2004

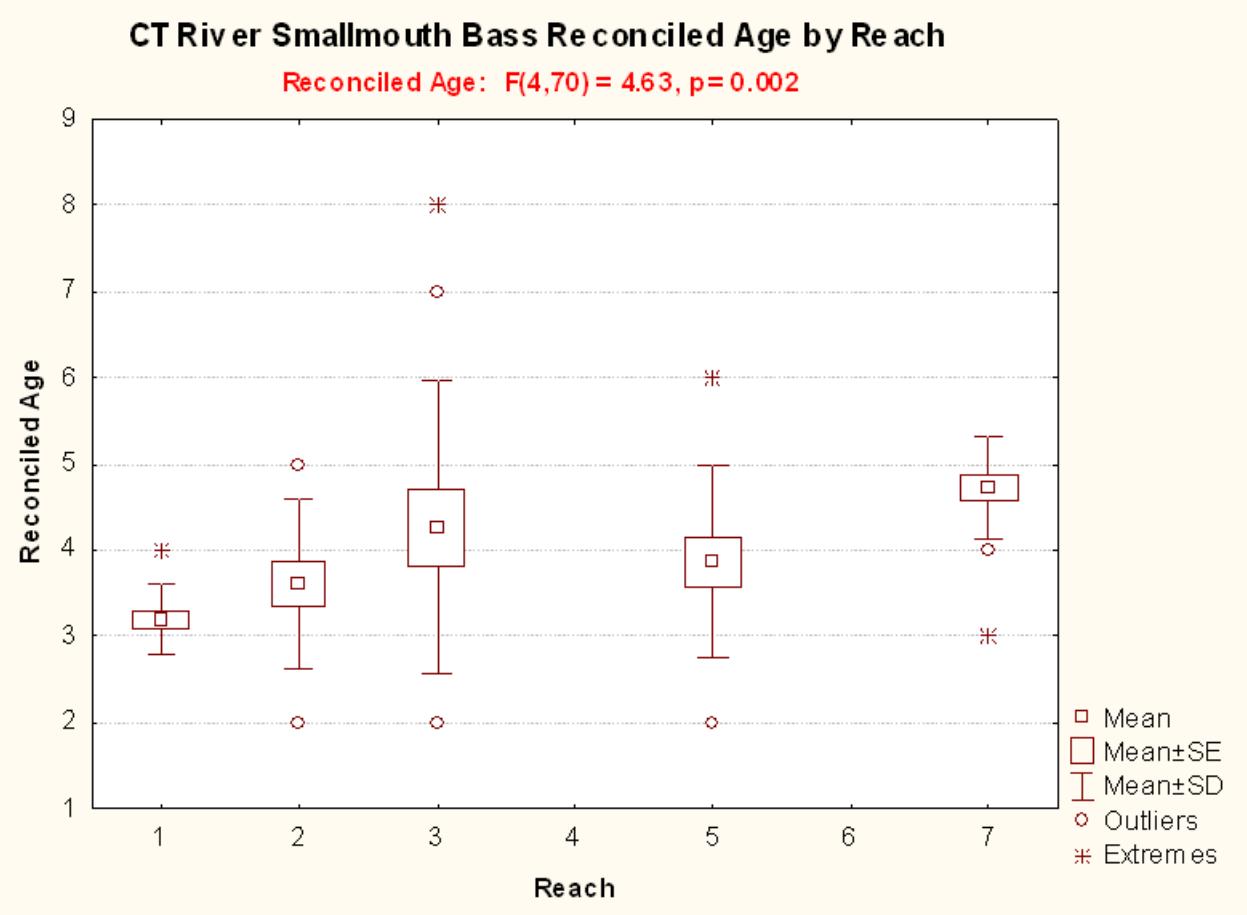

Figure 156. CT River Smallmouth Bass Reconciled Age by Reach

report. Age of sampled fish may account for some or all of the observed contaminant levels, as levels may increase with exposure and bioaccumulation. A graphical analysis of total mercury and coplanar PCB TEQs in whole fish and fillets was undertaken.

Smallmouth bass age differed by Reach (Figure 153)[51].

Figure 156 shows a statistically significant relationship between smallmouth reconciled age and Reach. Clearly Reach 7 sampled older smallmouth bass than other Reaches

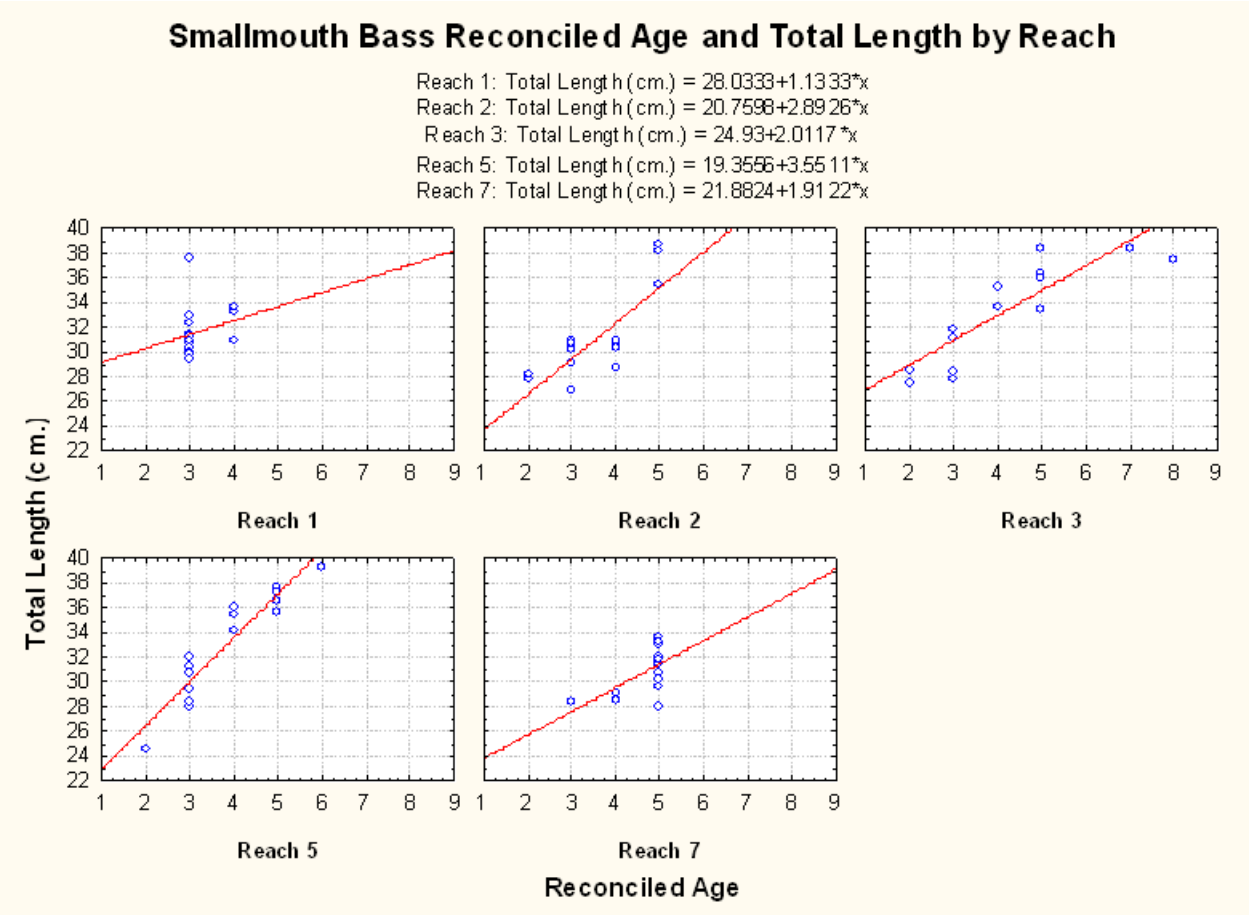

Figure 157. Smallmouth Bass Reconciled Age and Total Length by Reach

(Figures 157 and 158).

[51]Age is given as "reconciled age" indicating that in some instances indicators of age (scales and otoliths) might have conflicted and the strongest indicators were used.

Reconciled age, Reach and total mercury in filleted and whole smallmouth bass were found to be extremely significantly correlated (Table 58). Thus higher concentrations of mercury in smallmouth bass in upper Reaches may be reflective of greater age of sampled fish (Figures 156-158). Coplanar PCB TEQs were significantly negatively correlated with age in whole smallmouth bass. The possible cause of lower PCB TEQs in older smallmouth bass is unclear. One possibility is that young fish intake relatively larger body burdens of PCB TEQs that depurate as they age.

Table 58. Spearman Rank Order Correlations of Reach, Reconciled Age, Total Mercury in Whole and Filleted Smallmouth Bass

	Spearman R	p-level
Reconciled Age & Reach	0.46	3.10E-05
Reconciled Age & Hg-Fillet	0.61	7.76E-09
Reconciled Age & Hg-Whole	0.62	3.08E-09
Reconciled Age & Human TEQs	-0.33	3.91E-03
Reconciled Age & Fish TEQs	-0.29	0.01
Reconciled Age & Bird TEQs	-0.23	0.05

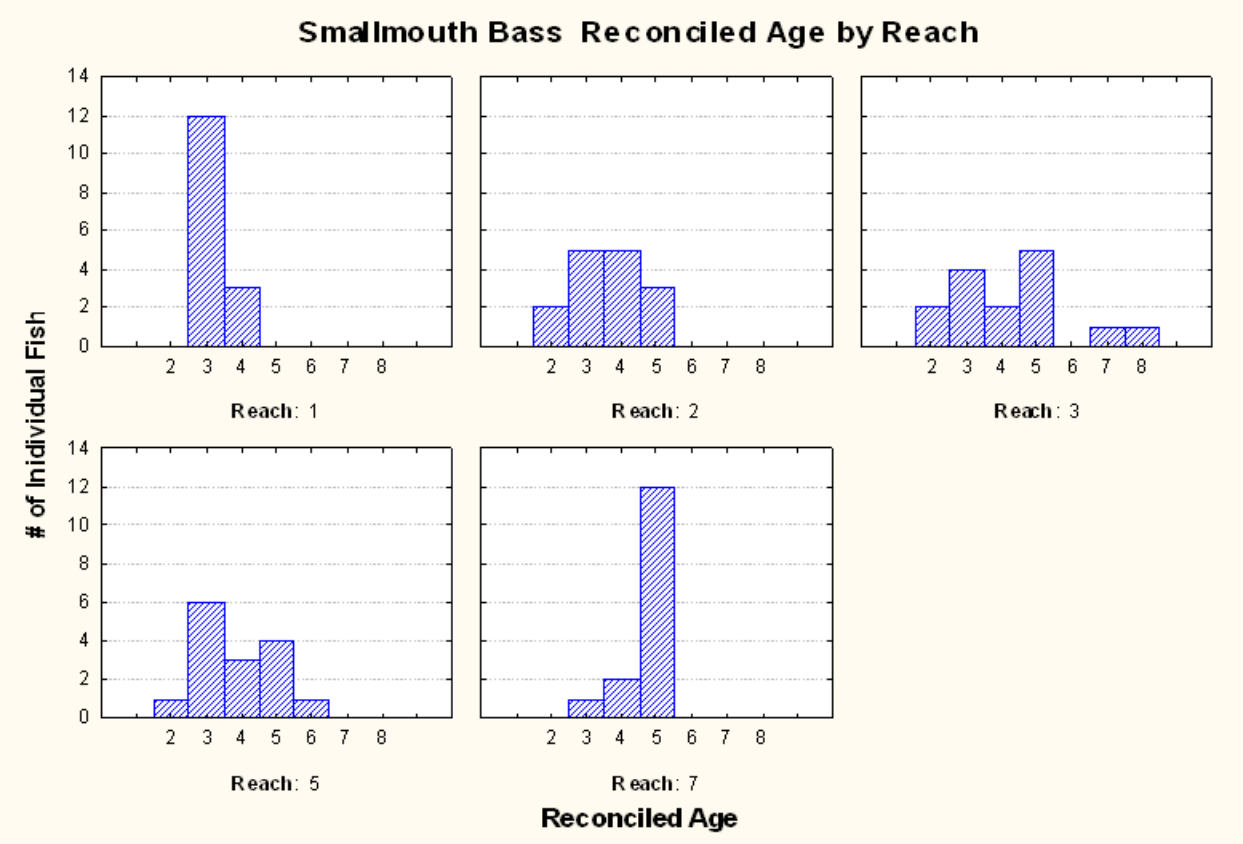

Figure 158. Smallmouth Bass Reconciled Age by Reach

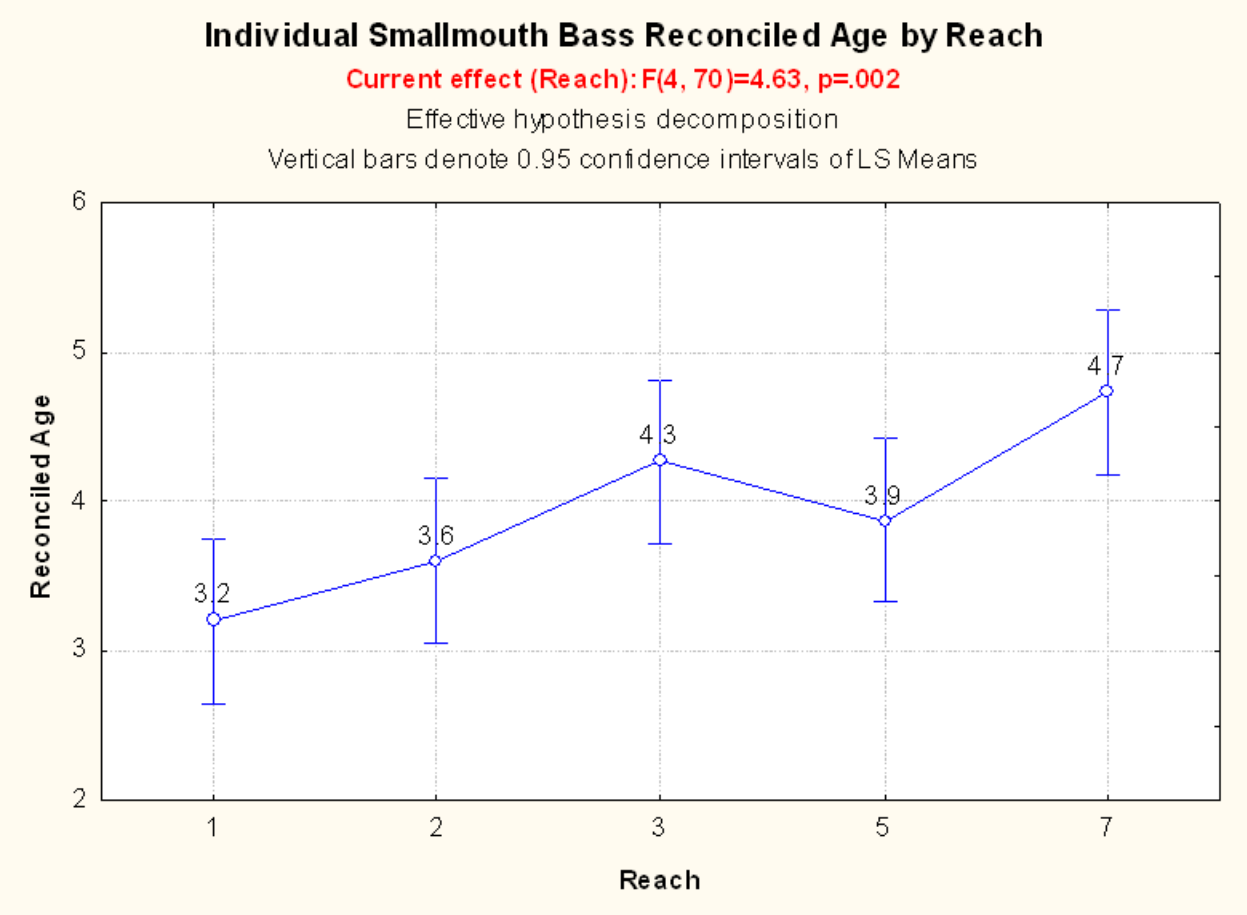

Figure 159. ANOVA of Individual Smallmouth Bass Reconciled Age by Reach

A one-way ANOVA of reconciled age in individual smallmouth bass found a significant effect for Reach (p= 0.002) (Figure 159). Table 59 summarizes the post-hoc pair-wise comparison by Reach of least square means of individual smallmouth bass reconciled age by Reach. Smallmouth bass sampled in Reach 3 were significantly older than those in Reach 1. Individual smallmouth bass sampled in Reach 7 were significantly older than smallmouth bass sampled in Reaches 1, 2, and 5.

Table 59. Comparison by Reach of Individual Smallmouth Bass Reconciled Age (Fisher's Least Significant Difference Post-Hoc Test of Least Square Means)

Reconciled Age - Least Square Means	3.2	3.6	4.3	3.9	4.7
Reach	1	2	3	5	7
1		0.31	0.01	0.09	1.92E-04
2			0.09	0.50	4.83E-03
3				0.31	0.23
5					0.03

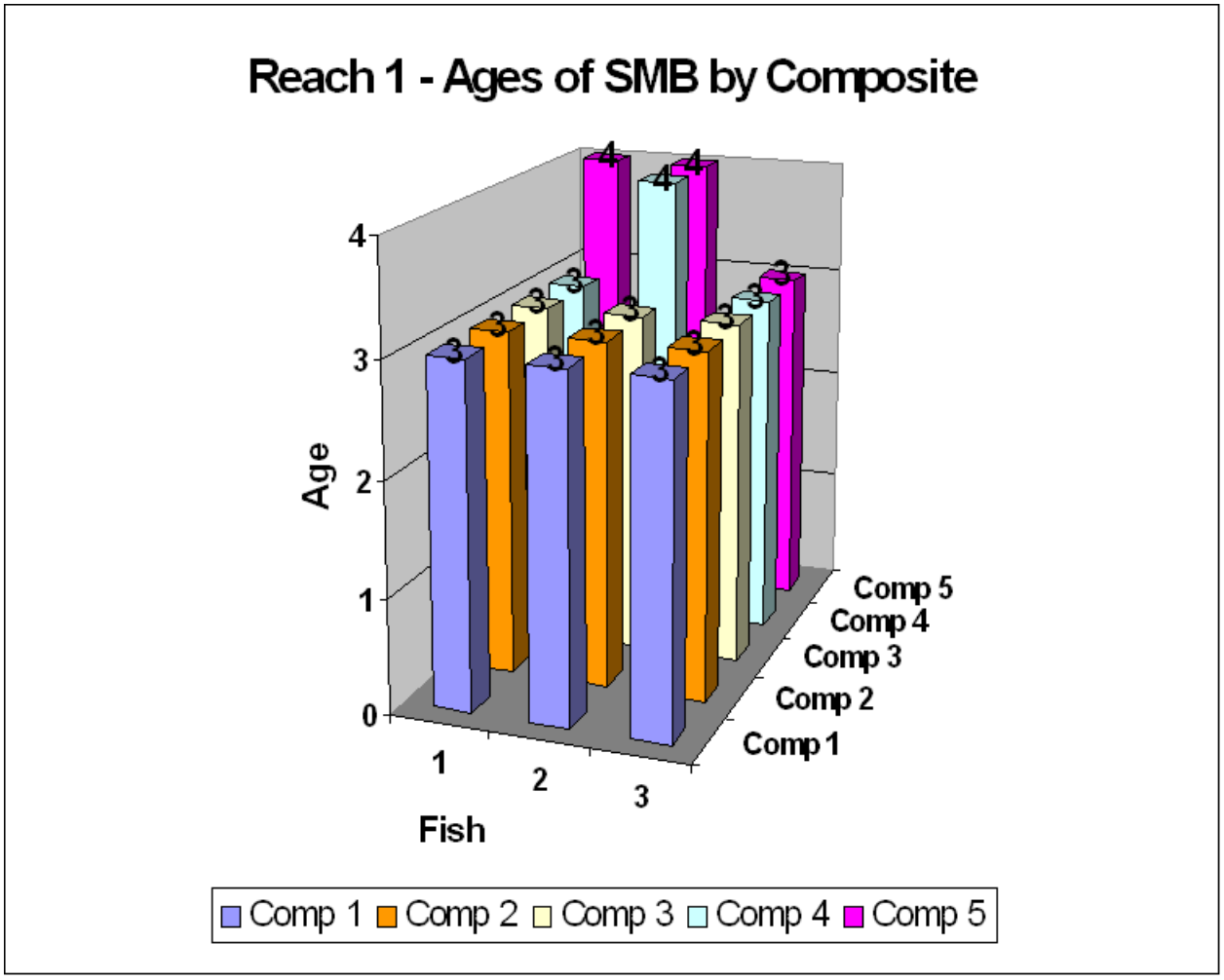

Figure 160. Reach 1 - Age of Individual Smallmouth Bass by Composite

Twelve of the fifteen sampled fish in Reach 1 were 3 years old (Figure 160). Composites 1, 2 and 3 were all composed of three year old SMB. Composite 4 had two three year old fish and one four year old fish. Composite 5 had a single three year old fish and two four year old fish. Note the order of composites varies, to allow clear depiction of all values.

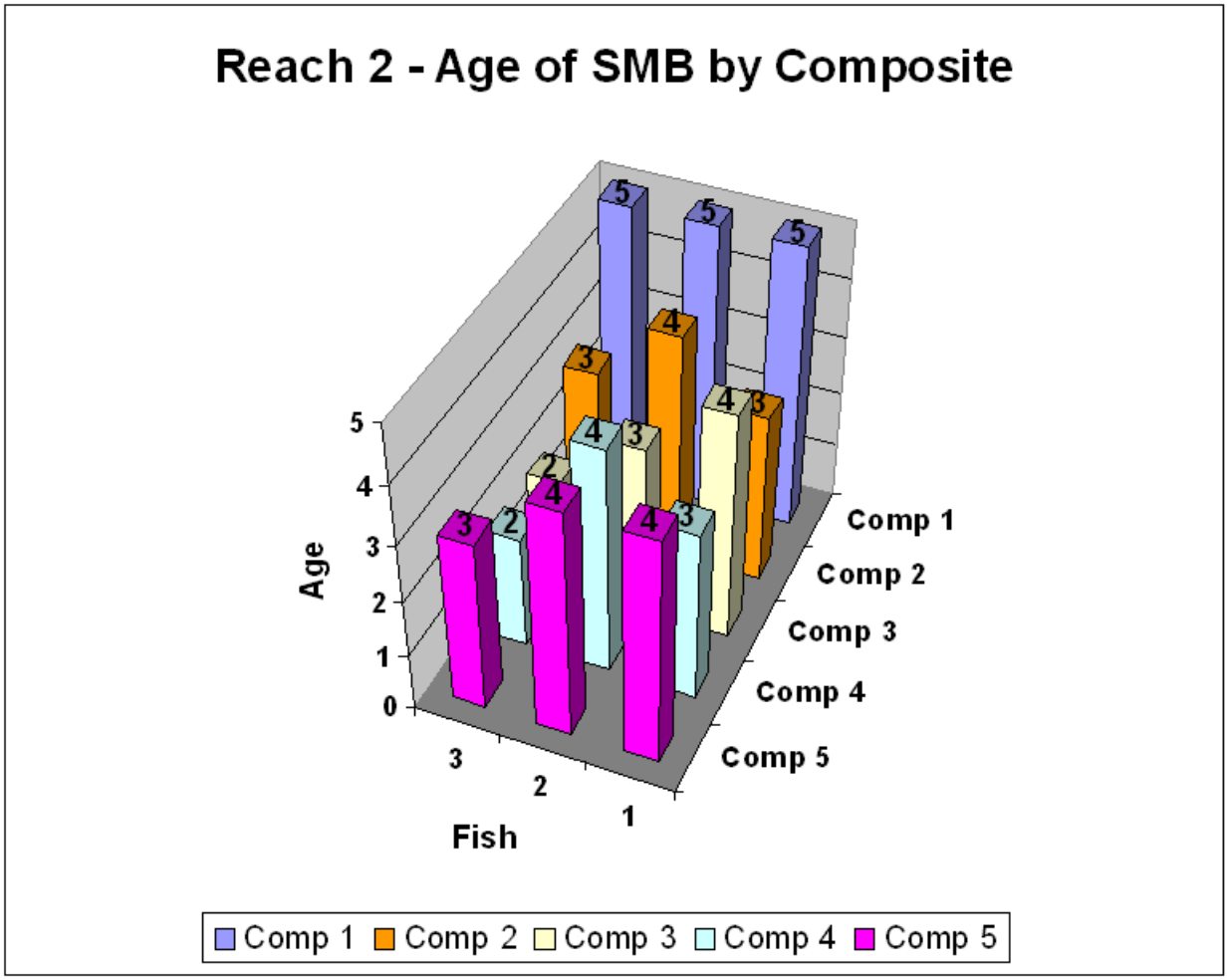

Figure 161. Reach 2 - Age of Individual Smallmouth Bass by Composite

Reach 2 had more heterogeneously aged composites than Reach 1 (Figure 161). Composite 1 contained three 5 year old fish. All four other composites had mixed age fish. Composite 2 had two 3 year old fish and one 4 year old fish. Composite 3 contained a 2 year old, a 3 year old, and a 4 year old fish. Composite 4 similarly contained a 2 year old, a 3 year old, and a 4 year old fish. Composite 5 contained a 3 year old and two 4 year old fish.

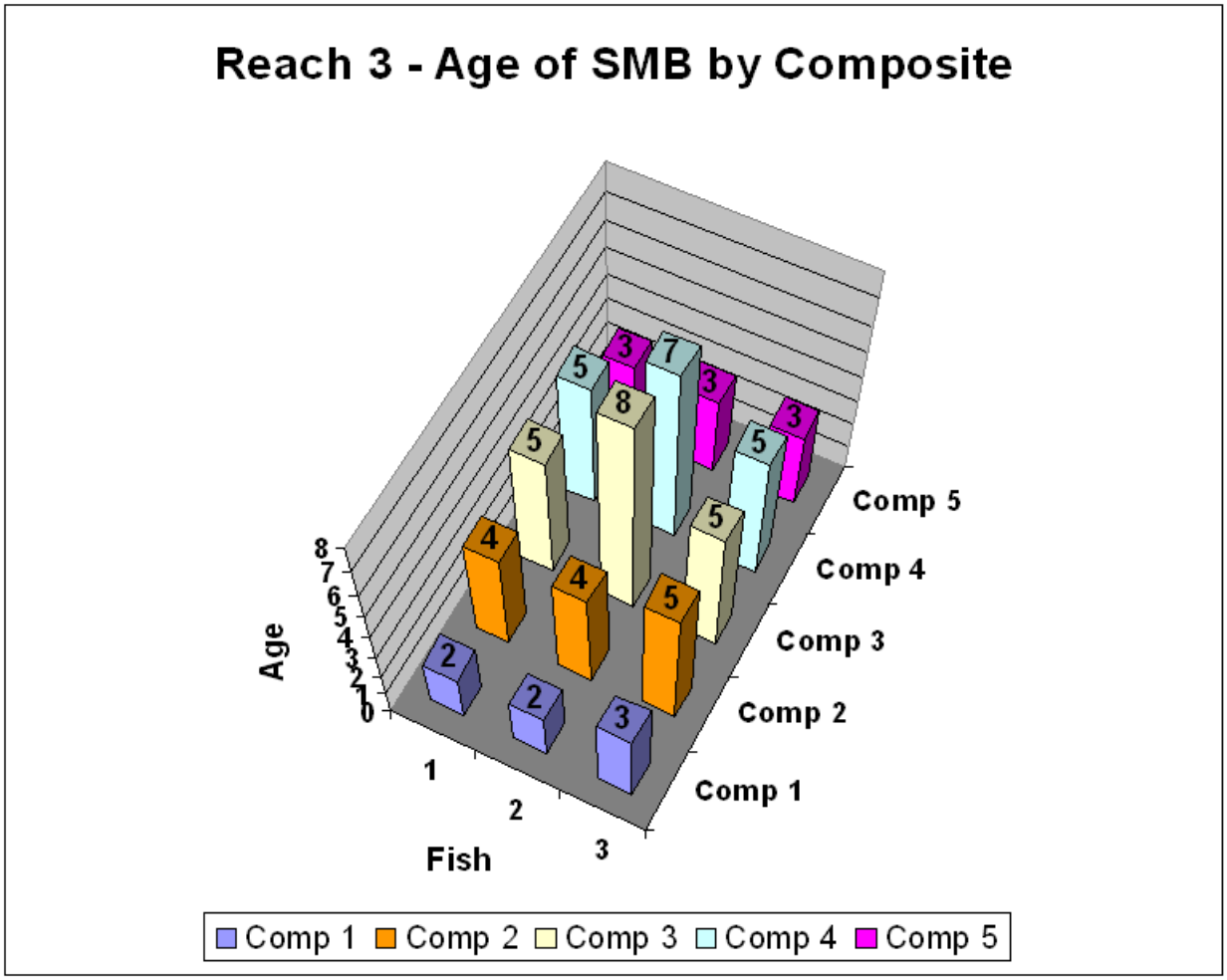

Figure 162. Reach 3 - Age of Individual Smallmouth Bass by Composite

Reach 3 had widely varying ages of fish (Figure 162). Composite 1 contained two 2 year old fish and a 3 year old fish. Composite 2 contained two 4 year old fish and a 5 year old fish. Composite 3 contained two 5 year old fish and a 8 year old fish. Composite 4 contained two 5 year old fish and a 7 year old fish. Composite 5 was the only homogeneously aged composite in Reach 3, with three 3 year old fish.

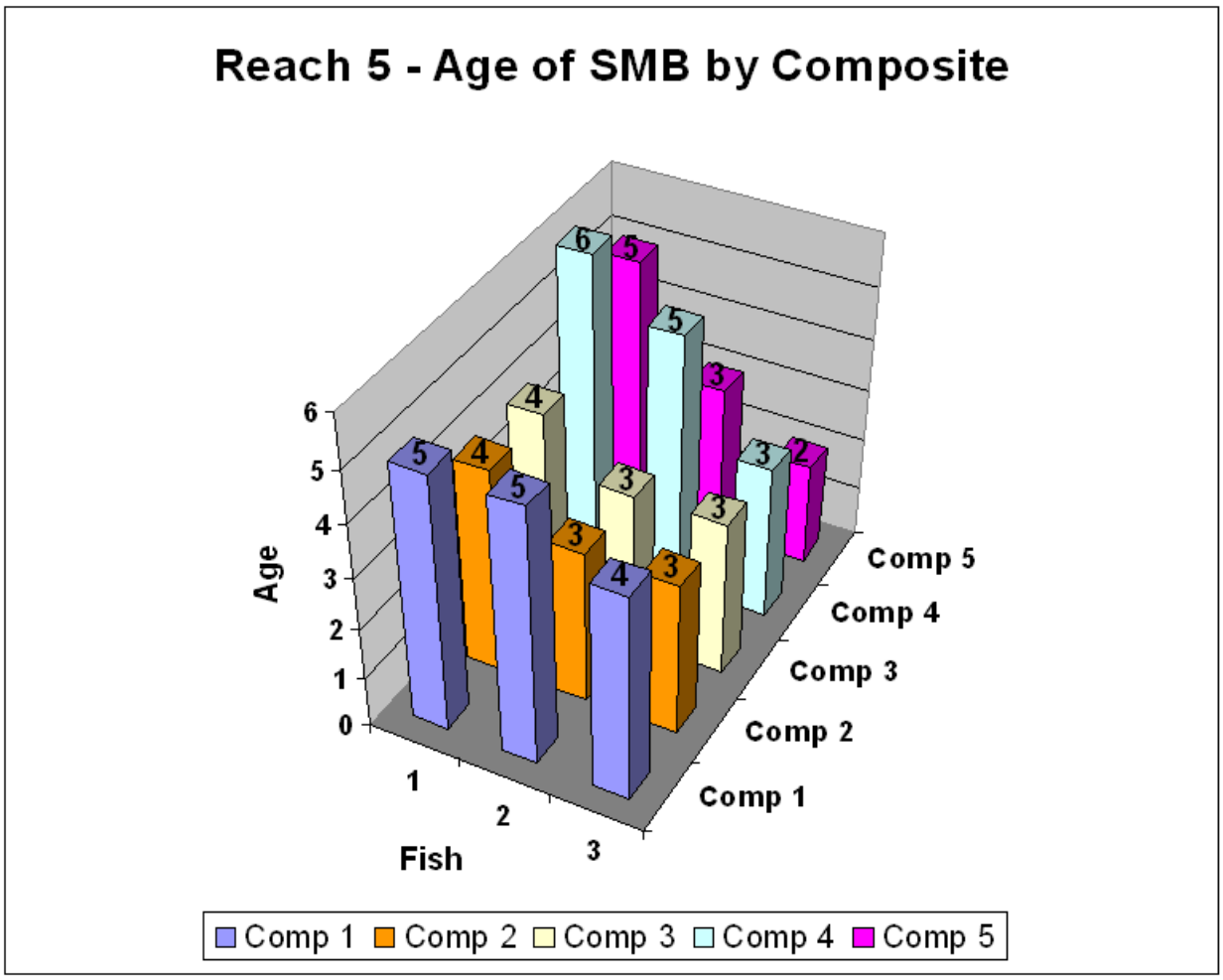

Figure 163. Reach 5 - Age of Individual Smallmouth Bass by Composite

Reach 5 had no evenly aged composites (Figure 163). Composite 1 contained two 5 year old fish and a 4 year old fish. Composite 2 contained two 3 year old fish and a 4 year old fish. Composite 3 also contained two 3 year old fish and a 4 year old fish. Composite contained a 3 year old, a 5 year old, and a 6 year old fish. Composite 5 contained a 2 year old, a 3 year old and a 5 year old fish.

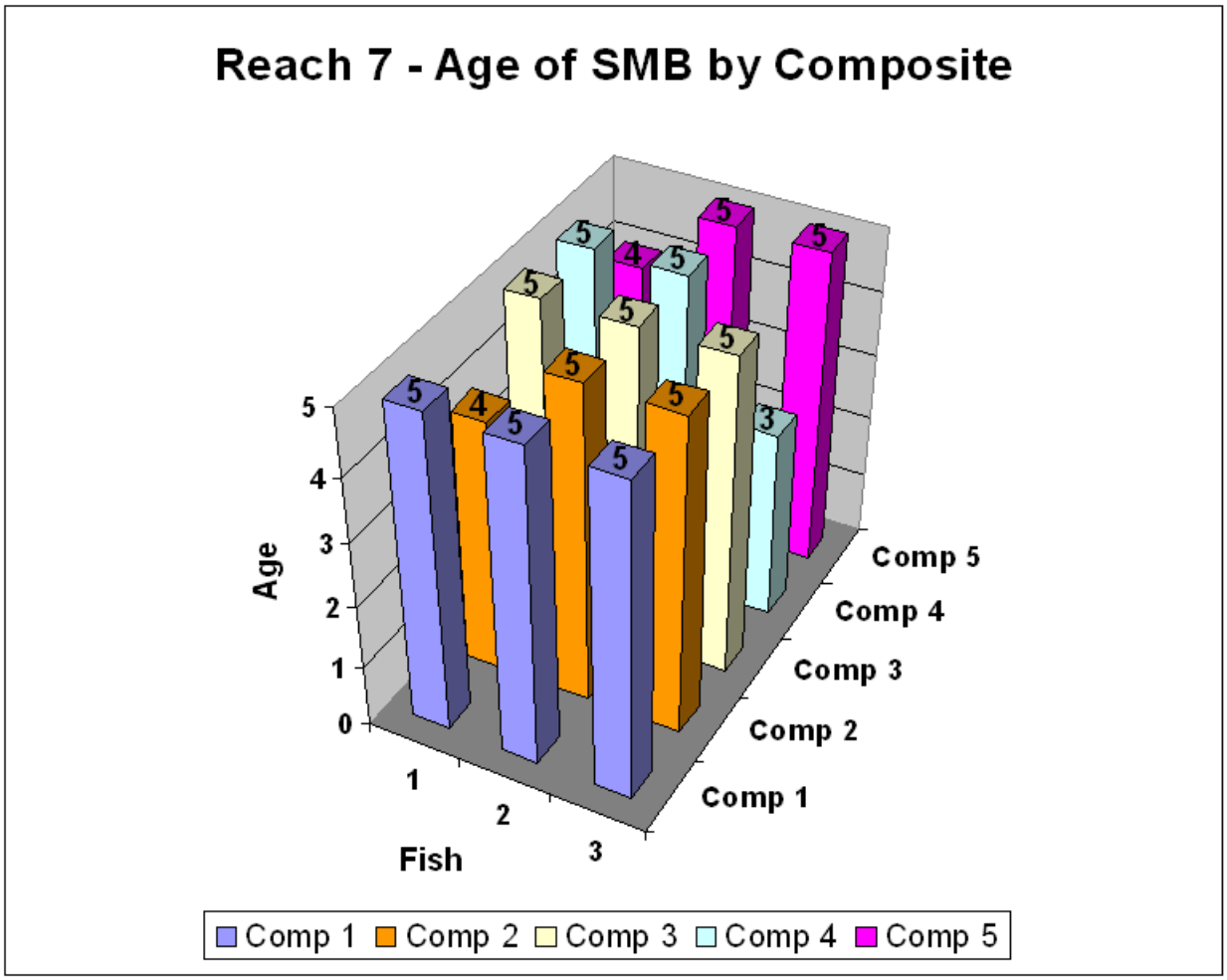

Figure 164. Reach 7 - Age of Individual Smallmouth Bass by Composite

Reach 7 was as homogeneously aged[52] as Reach 1 with 12 of the 15 sampled fish being of the same age (Figure 164). However, these twelve fish were all 5 years of age, compared to the twelve 3 year old fish in Reach 1. Composite 1 was composed entirely of 5 year old fish. Composite 2 contained a 4 year old fish and two 5 year old fish. Composite 3 was also evenly aged, with all three fish being 5 years of age. Composite 4 had a 3 year old fish and two 5 year old fish. Composite 5 contained a 4 year old fish and two 5 year old fish.

[52] In Reach 7 age was determined solely from scales, not otoliths (Smithwood 2004).

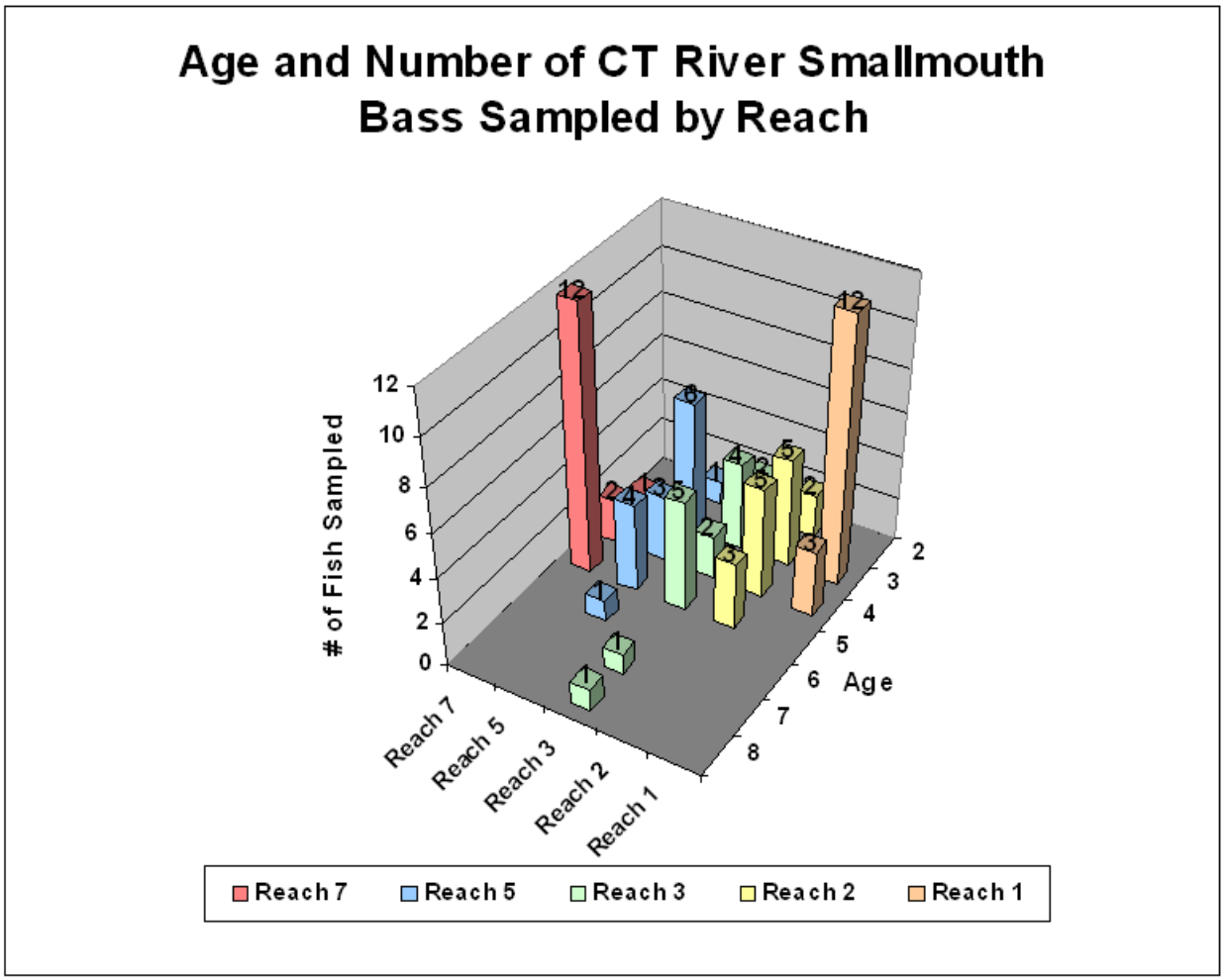

Figure 165. Age and Number of Smallmouth Bass Sampled by Reach

Figure 165 summarizes Figures 159 through 164.

6.2 Total Mercury and Age of Whole Smallmouth Bass and Fillets

6.2.1 Whole Smallmouth Bass

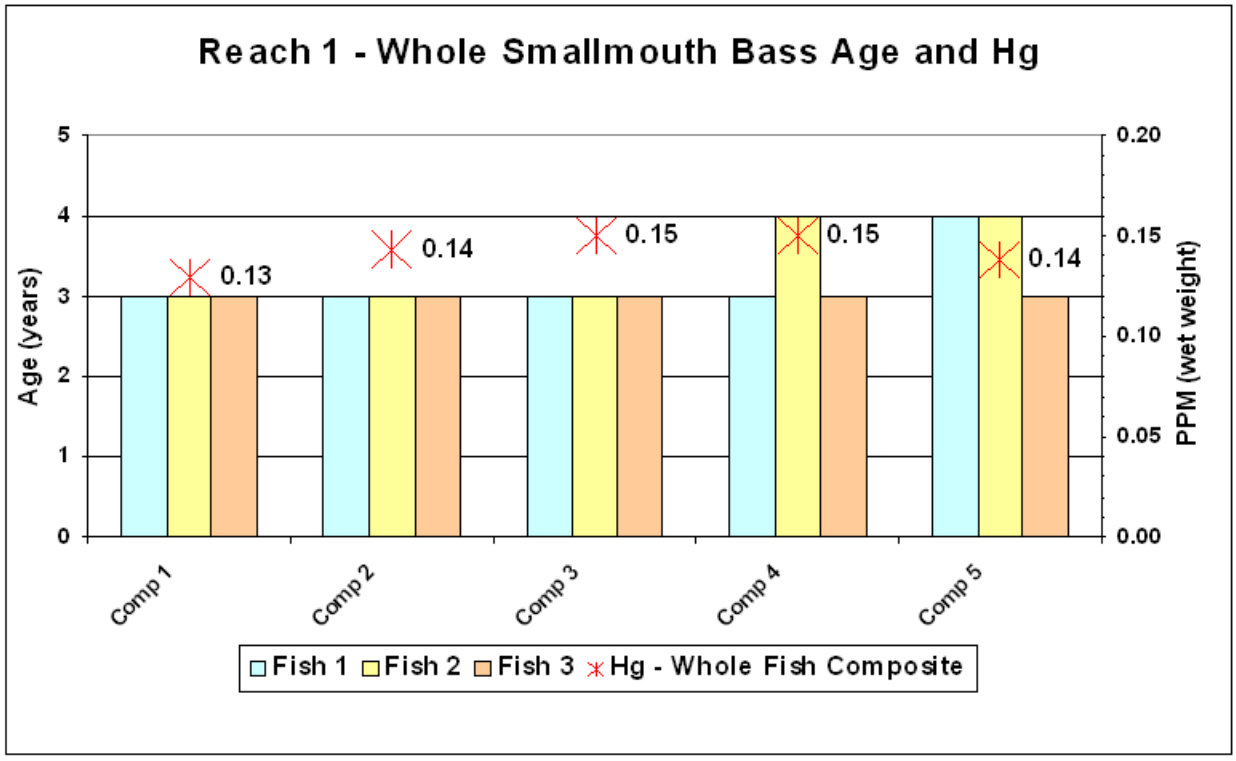

Figure 166. Reach 1 - Total Mercury and Age of Whole Smallmouth Bass

Reach 1 was fairly even aged and displayed similarly homogeneous total mercury levels in whole smallmouth bass (Figure 166).

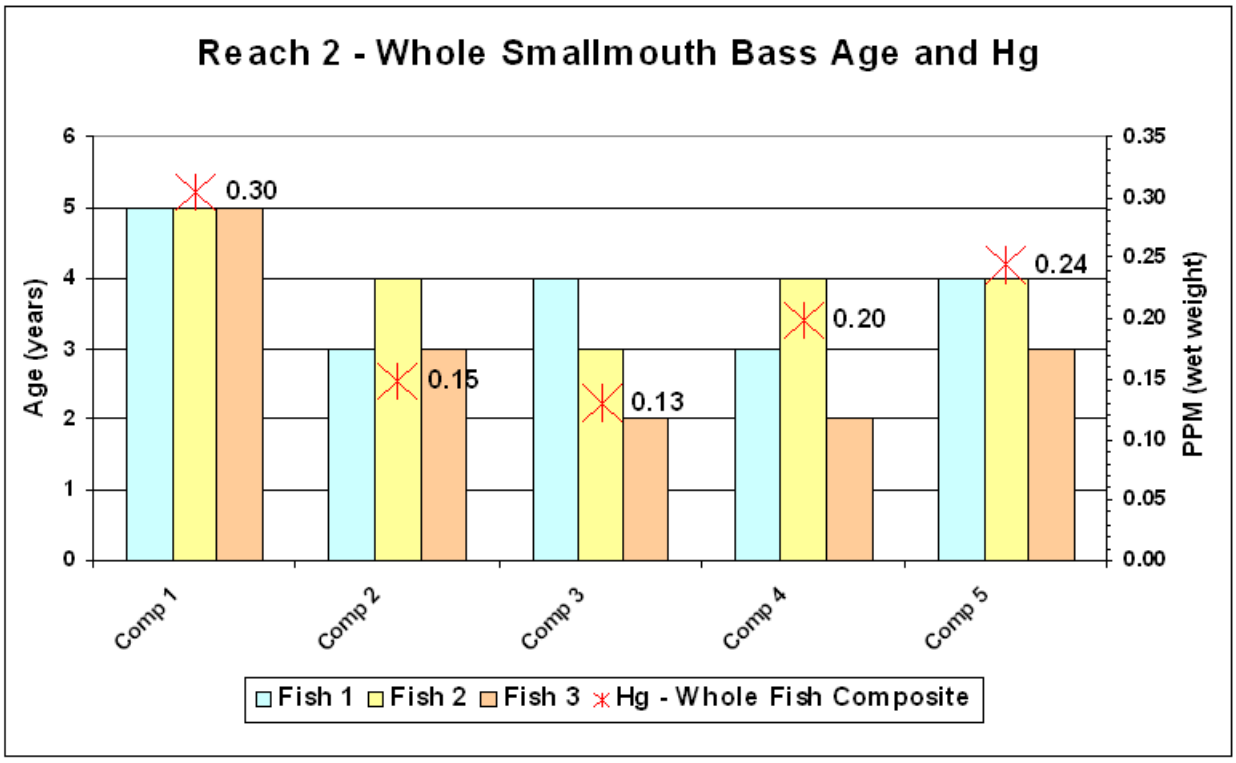

Figure 167. Reach 2 - Total Mercury and Age of Whole Smallmouth Bass

Reach 2 was more heterogenously aged than Reach 1 and also displayed a much wider range of total mercury values in whole smallmouth bass composites (Figure 167).

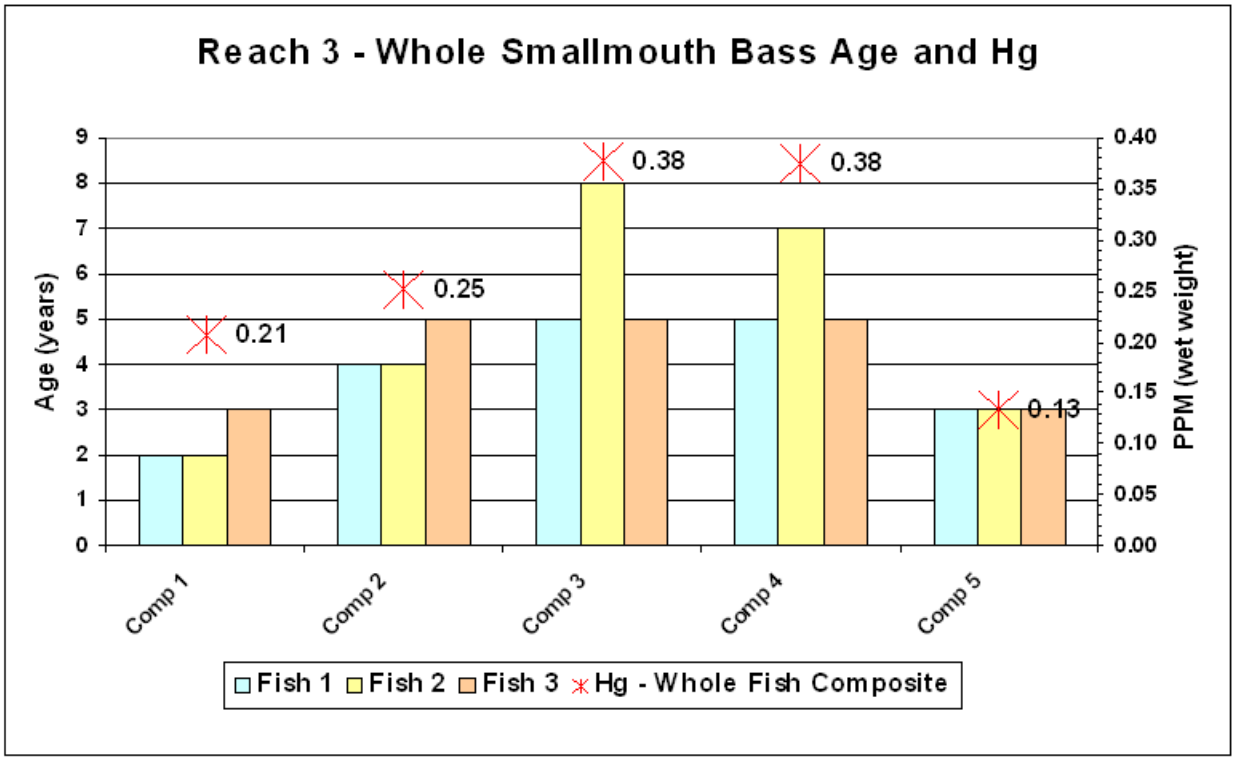

Figure 168. Reach 3 - Total Mercury and Age of Whole Smallmouth Bass

Reach 3 had the most widely aged composites of all five sampled Reaches (Figure 168). Reach 3 also displayed the most widely varying total mercury levels in whole smallmouth bass, with Composites 3 and 4 having nearly three times the total mercury in Composite 5.

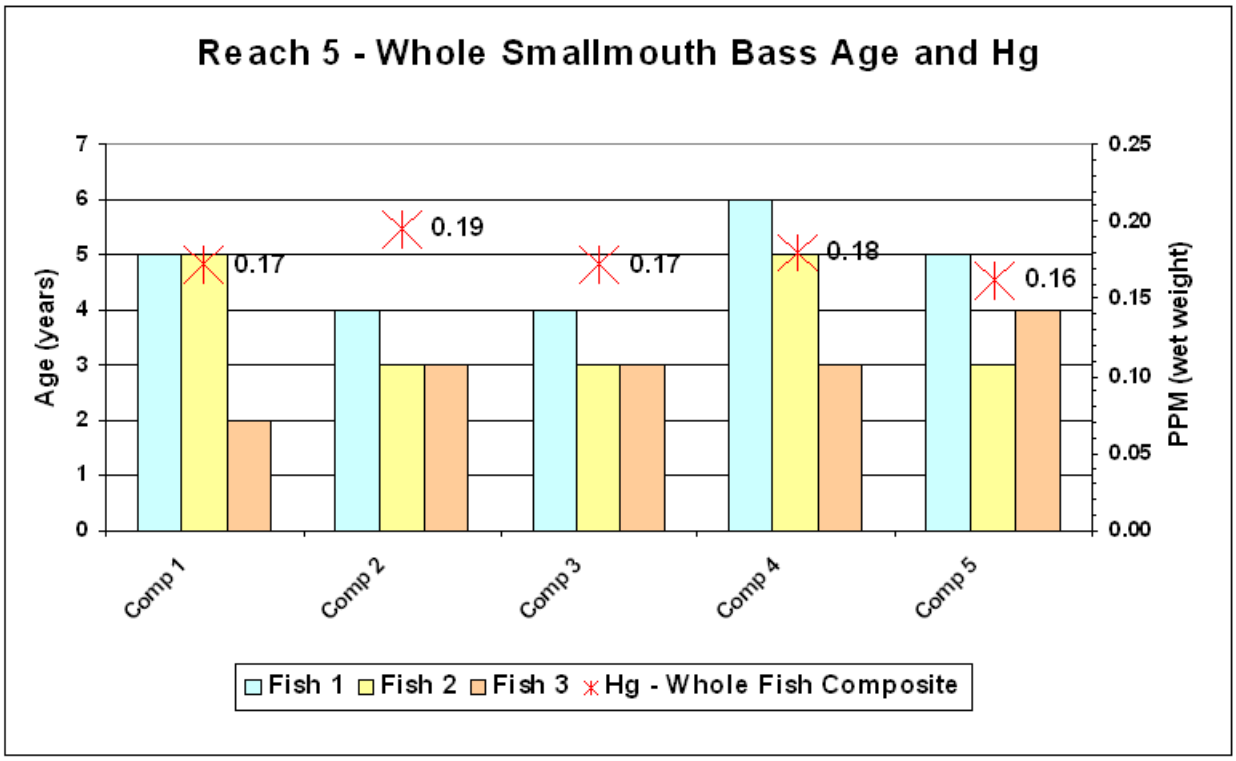

Figure 169. Reach 5 - Total Mercury and Age of Whole Smallmouth Bass

Reach 5 had heterogeneously aged Composites but displayed very similar total mercury values (Figure 169).

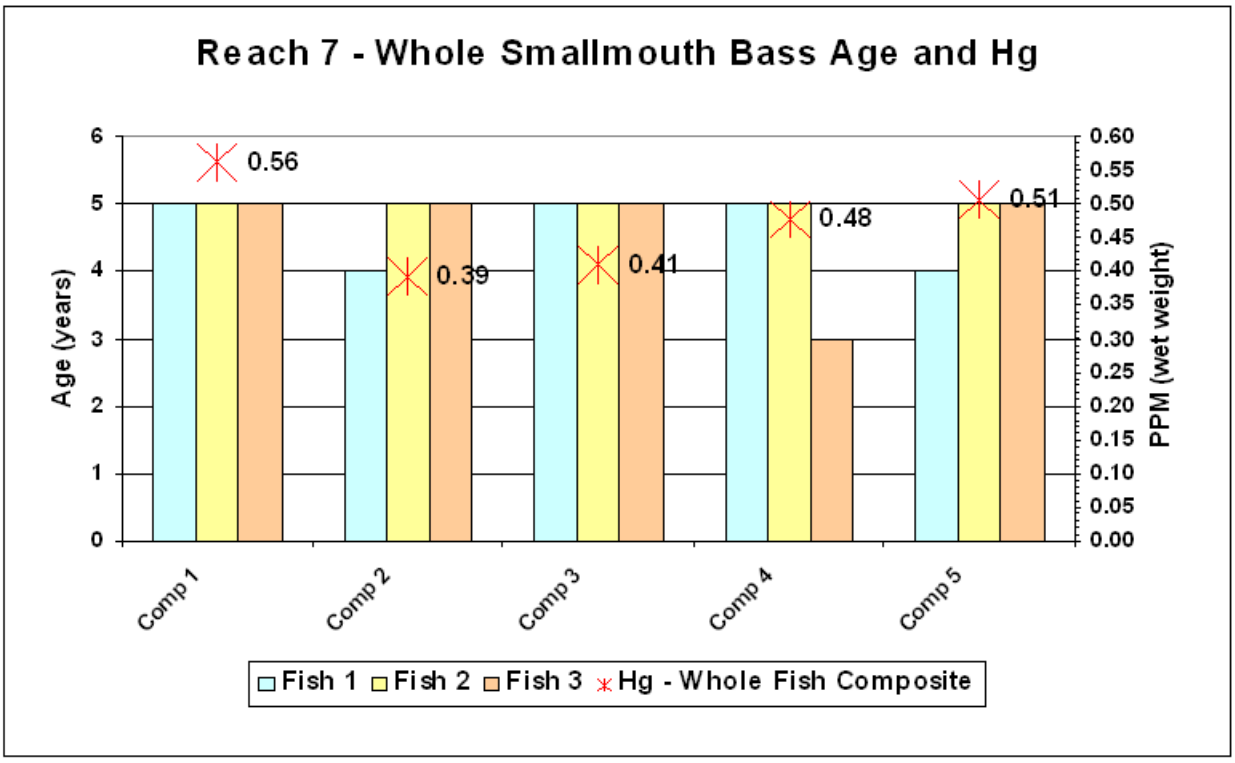

Figure 170. Reach 7 - Total Mercury and Age of Whole Smallmouth Bass

Reach 7 had both the oldest aged Composites of all five Reaches, but also the highest total mercury level with fairly similar values in all five Composites (Figure 170). Age would appear to be a factor in the significantly higher mercury observed in Reach 7, although only scales, not otiliths, were used in aging smallmouth bass in Reach 7.

6.2.2 Smallmouth Bass Fillets

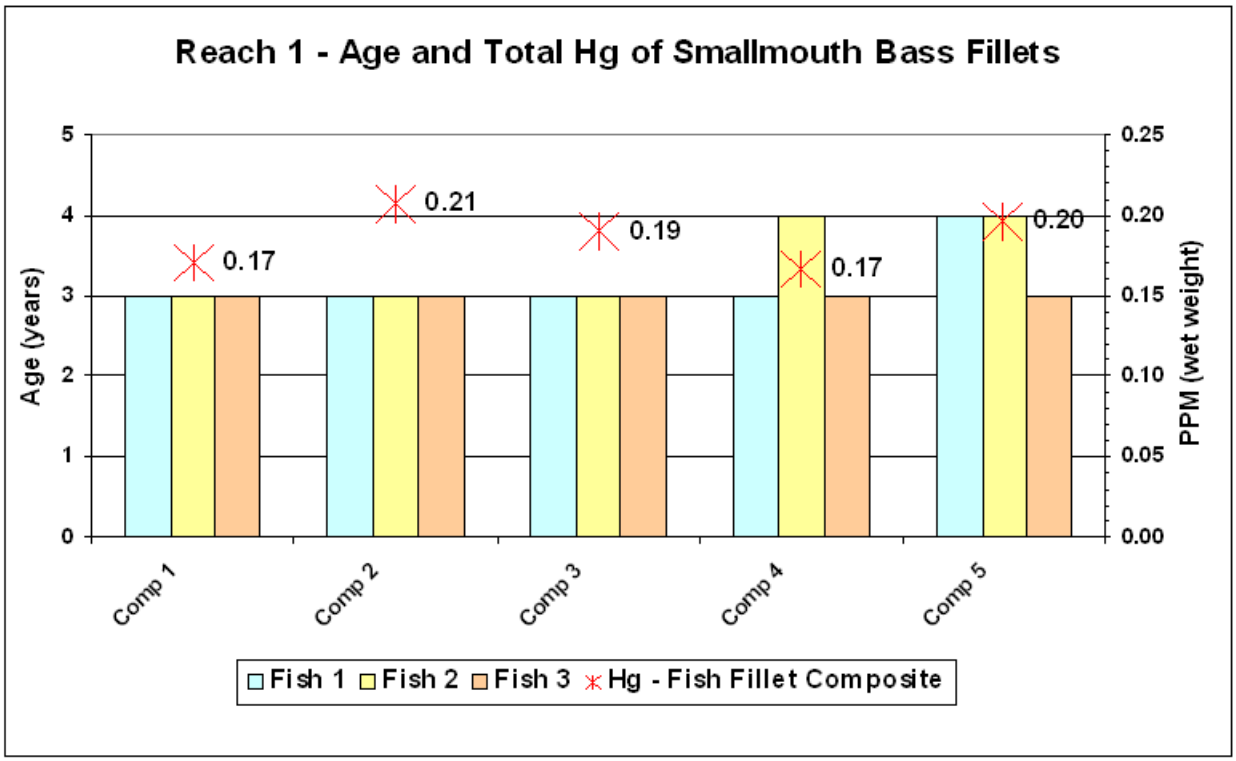

Figure 171. Reach 1 - Total Mercury and Age of Smallmouth Bass Fillets

Quite homogeneous total mercury was observed smallmouth bass fillet Composites in Reach 1, as for whole fish Composites (Figure 171).

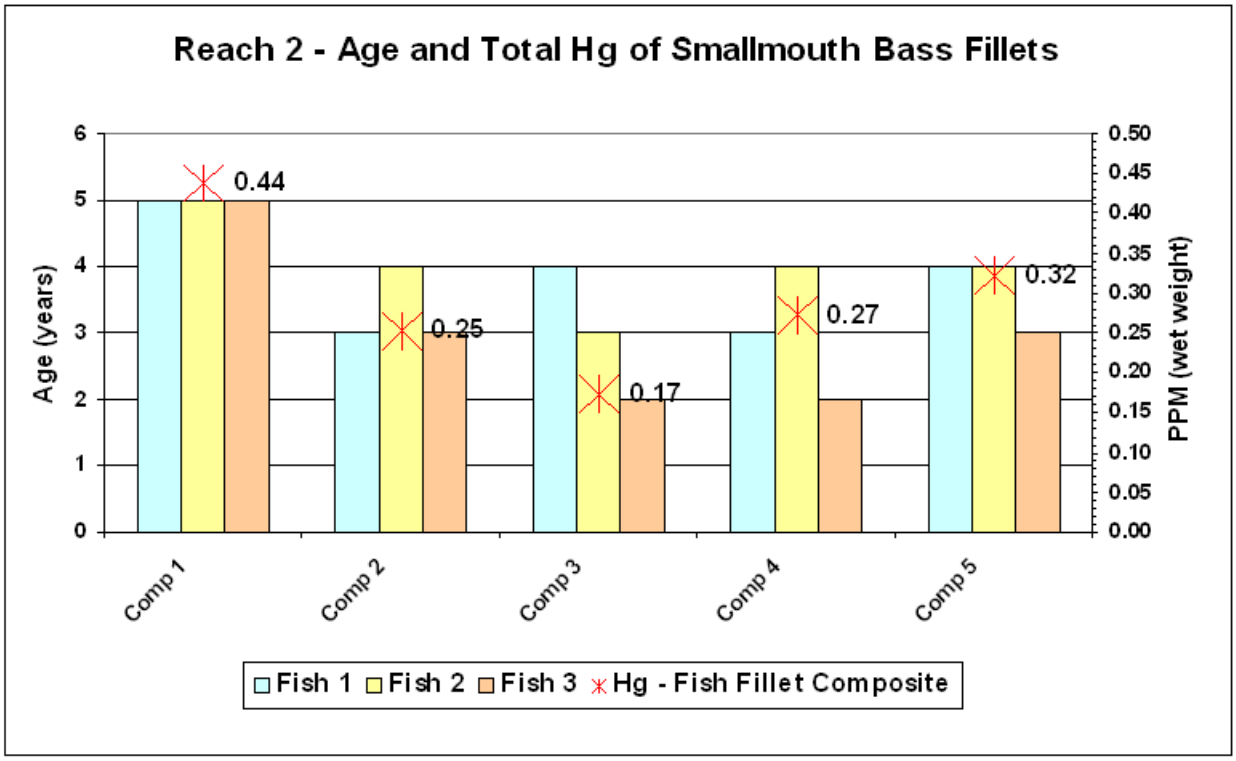

Figure 172. Reach 2 - Total Mercury and Age of Smallmouth Bass Fillets

A wider range of total mercury values was observed in Reach 2 in fillets than in whole fish Composites (Figure 172).

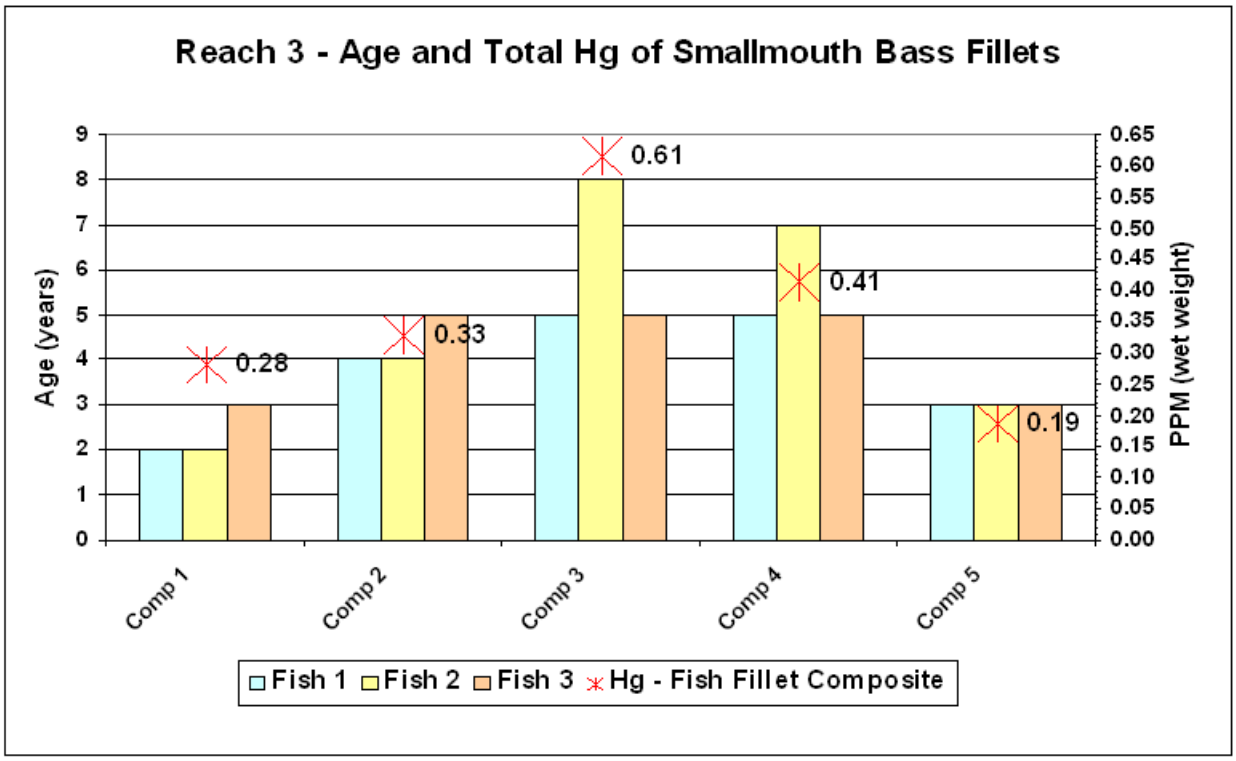

Figure 173. Reach 3 - Total Mercury and Age of Smallmouth Bass Fillets

As for whole fish, Reach 3 fillet Composites displayed widely varying total mercury levels (Figure 173). However, mercury levels in smallmouth bass fillets did appear to correspond to fish age.

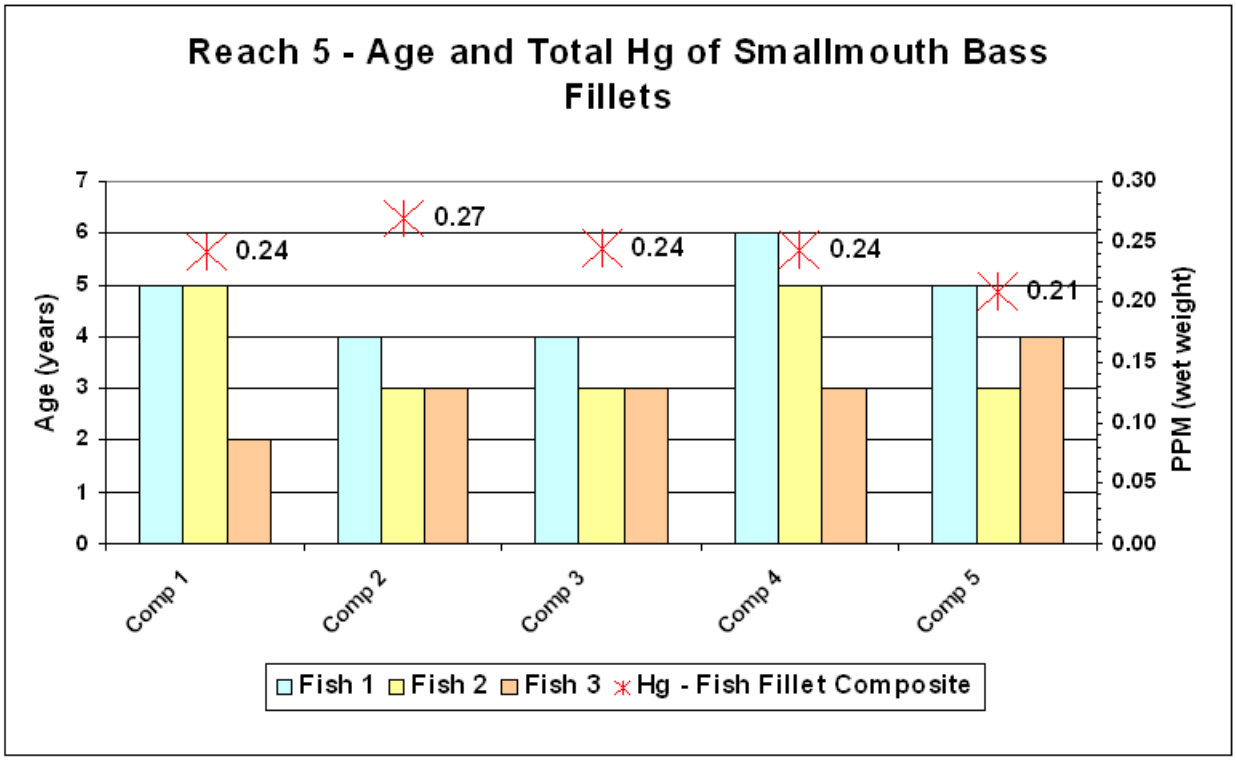

Figure 174. Reach 5 - Total Mercury and Age of Smallmouth Bass Fillets

As for fish, Reach 5 displayed quite similar total mercury in smallmouth bass fillet Composites (Figure 174).

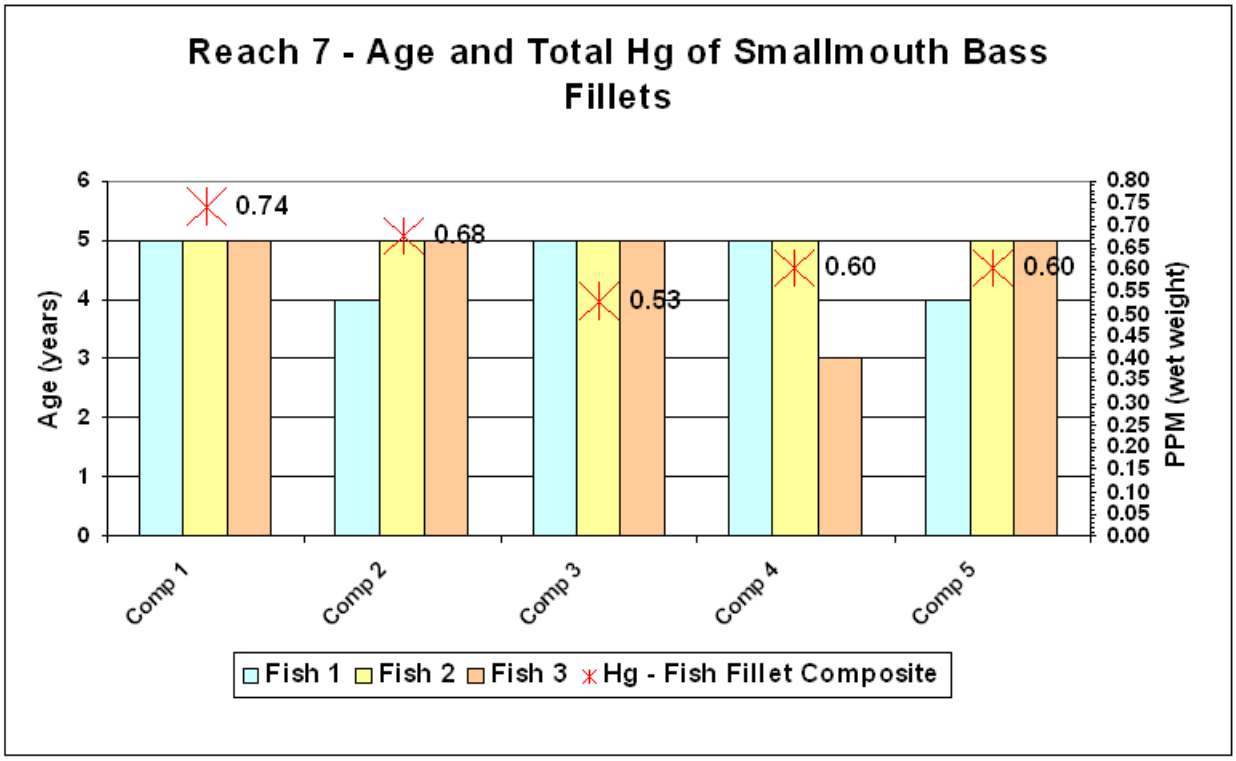

Figure 175. Reach 7 - Total Mercury and Age of Smallmouth Bass Fillets

Filleted smallmouth bass in Reach 7 displayed the highest total mercury of all five Reaches and the oldest composites (Figure 175).

6.2.3 Summary of Total Mercury and Age of Smallmouth Bass

Reach 1 was fairly even aged, with relatively similar mercury levels in all whole smallmouth bass composites. Reach 2 was more variably aged than Reach 1 and also displayed a much wider range of total mercury values in whole smallmouth bass composites. Reach 3 had the most widely aged composites of all five sampled Reaches. Reach 3 also displayed the most widely varying total mercury levels in whole smallmouth bass, with Composites 3 and 4 having nearly three times the total mercury in Composite 5. Reach 5 had heterogeneously aged Composites but displayed very similar total mercury values. Reach 7 had both the oldest aged Composites of all five Reaches, but also the highest total mercury level with fairly similar values in all five Composites. Age would appear to be a factor in the significantly higher mercury observed in Reach 7 and possibly other Reaches. Given the high correlation between total mercury in whole and filleted smallmouth bass very similar patterns were observed between age and total mercury.

6.3 Coplanar PCB TEQs and Age of Whole Smallmouth Bass

6.3.1 Human/Mammalian Receptor Coplanar PCB TEQs and Age

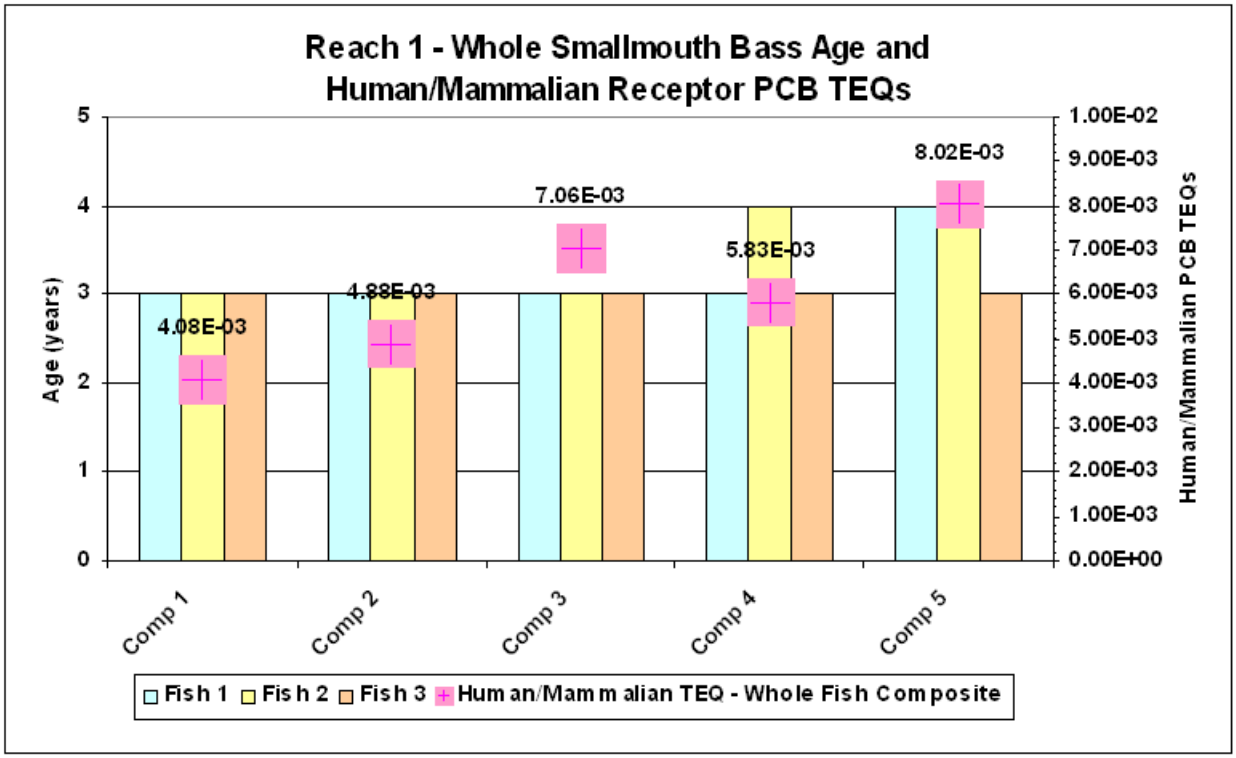

Figure 176. Reach 1 - Whole Smallmouth Bass Age and Human/Mammalian Receptor PCB TEQs

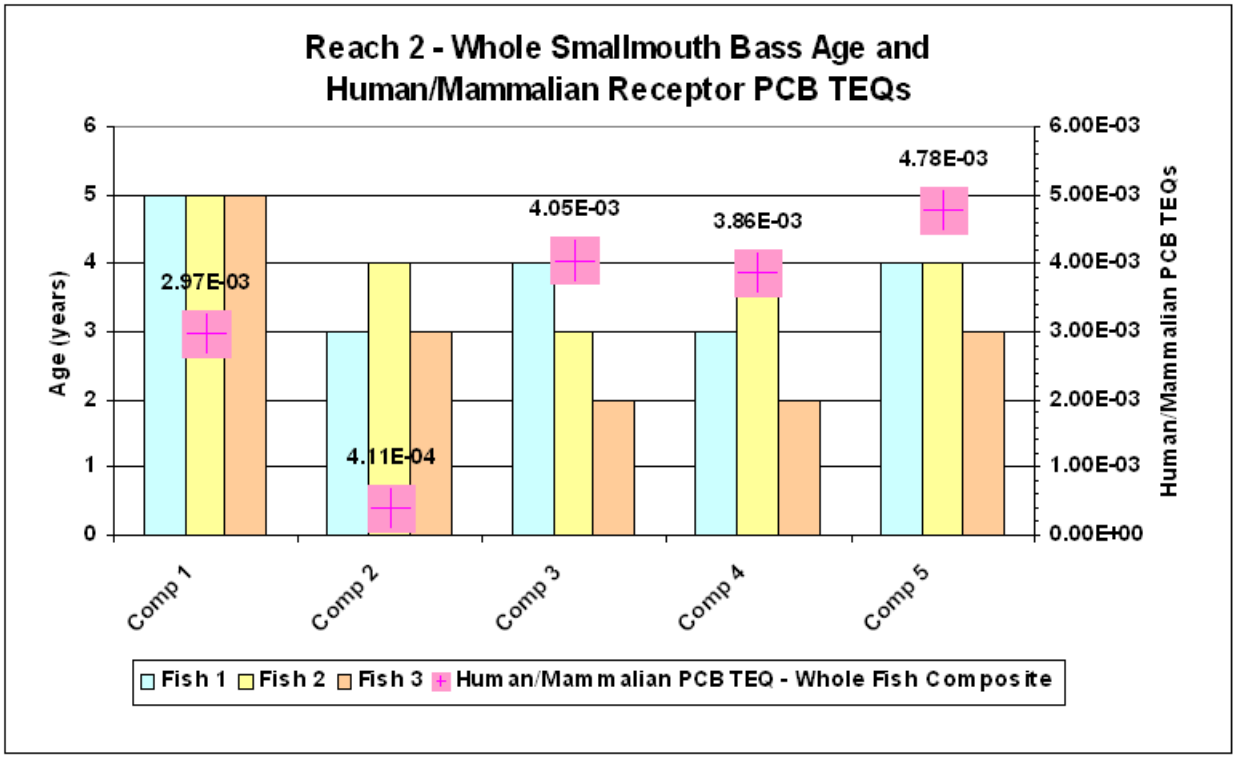

Figure 177. Reach 2 - Whole Smallmouth Bass Age and Human/Mammalian Receptor PCB TEQs

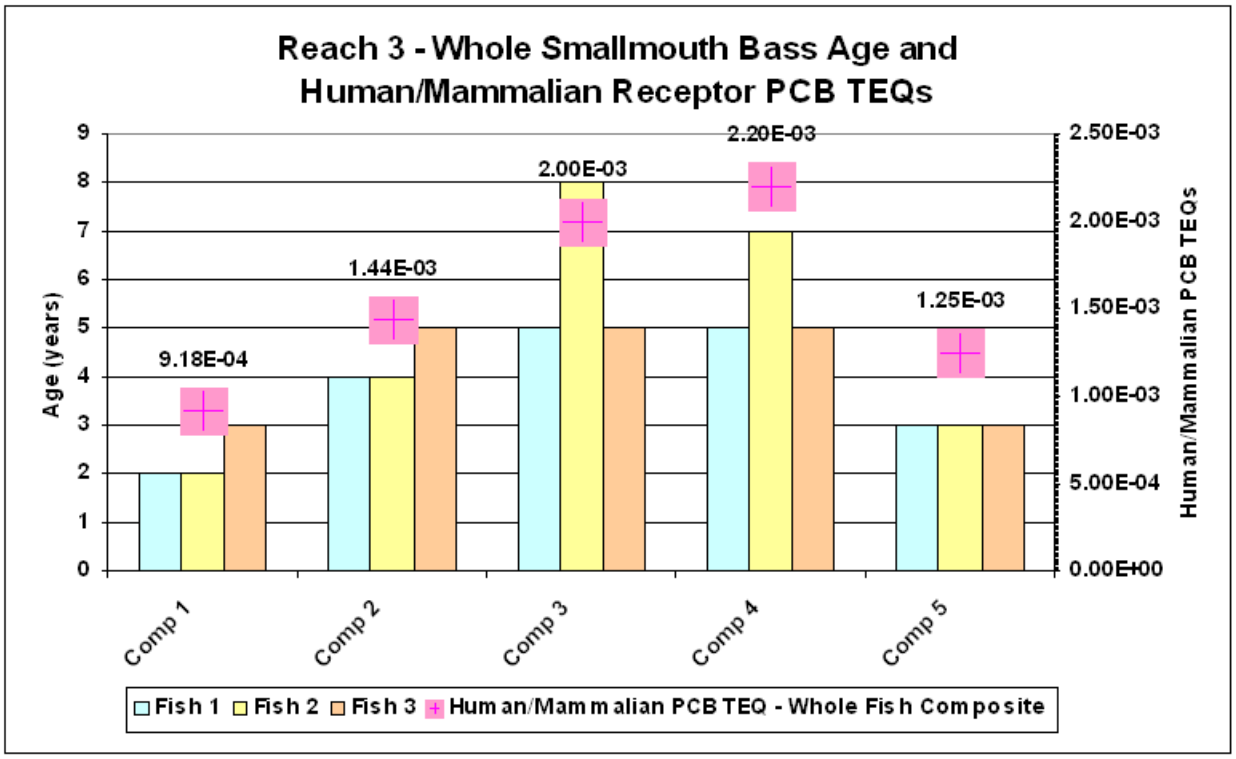

Figure 178. Reach 3 - Whole Smallmouth Bass Age and Human/Mammalian Receptor PCB TEQs

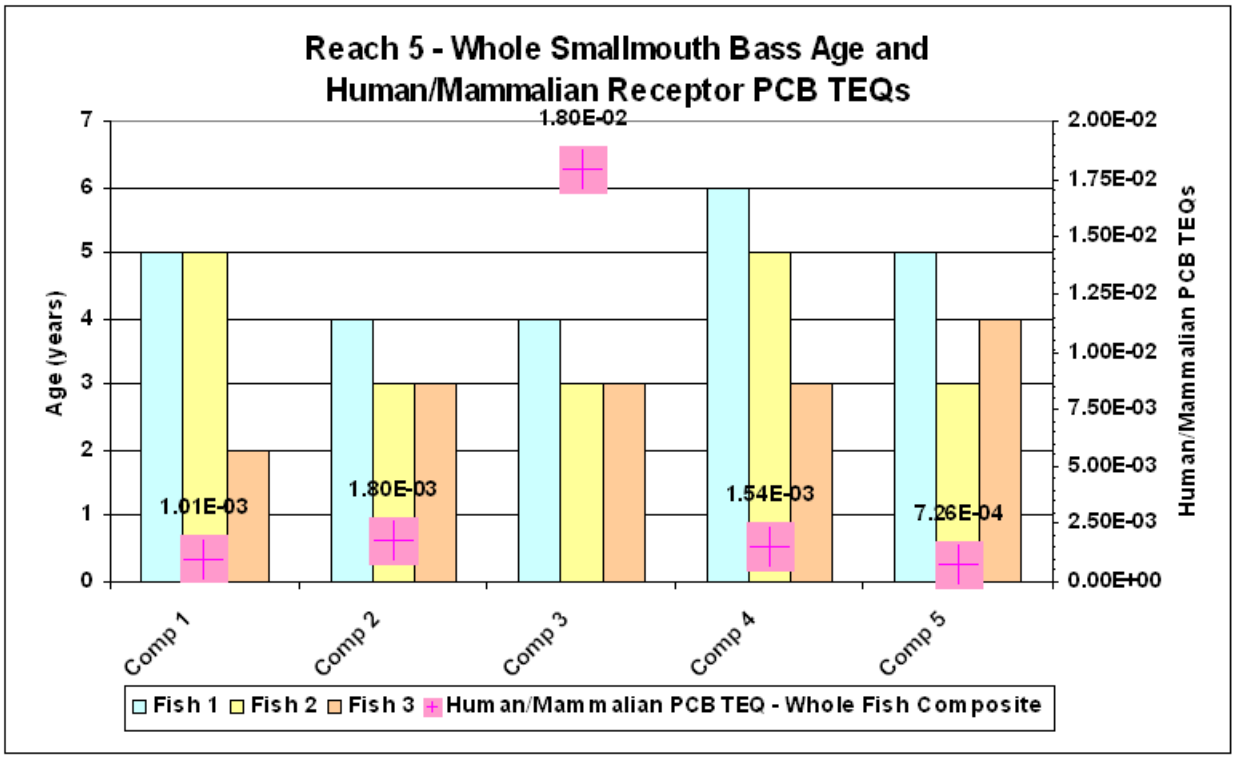

Figure 179. Reach 5 - Whole Smallmouth Bass Age and Human/Mammalian Receptor PCB TEQs

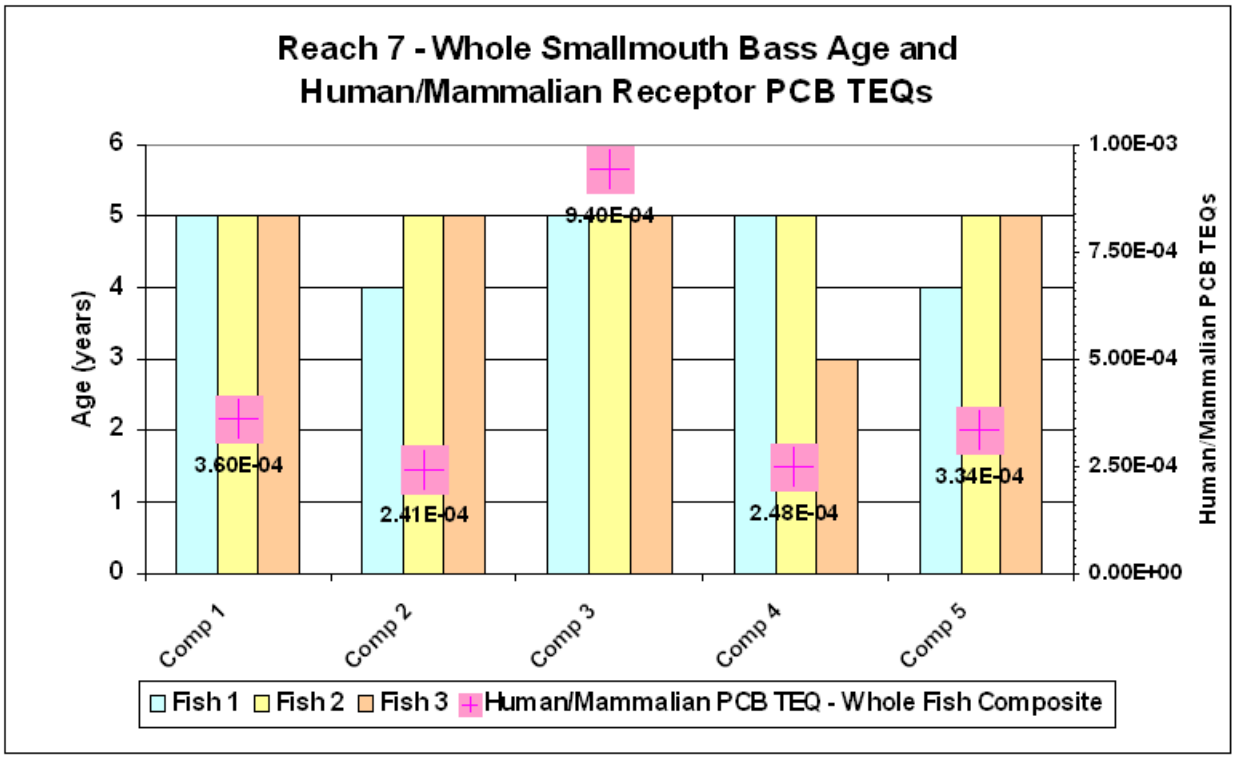

Figure 180. Reach 7 - Whole Smallmouth Bass Age and Human/Mammalian Receptor PCB TEQs

6.3.2 Fish Receptor Coplanar PCB TEQs and Age

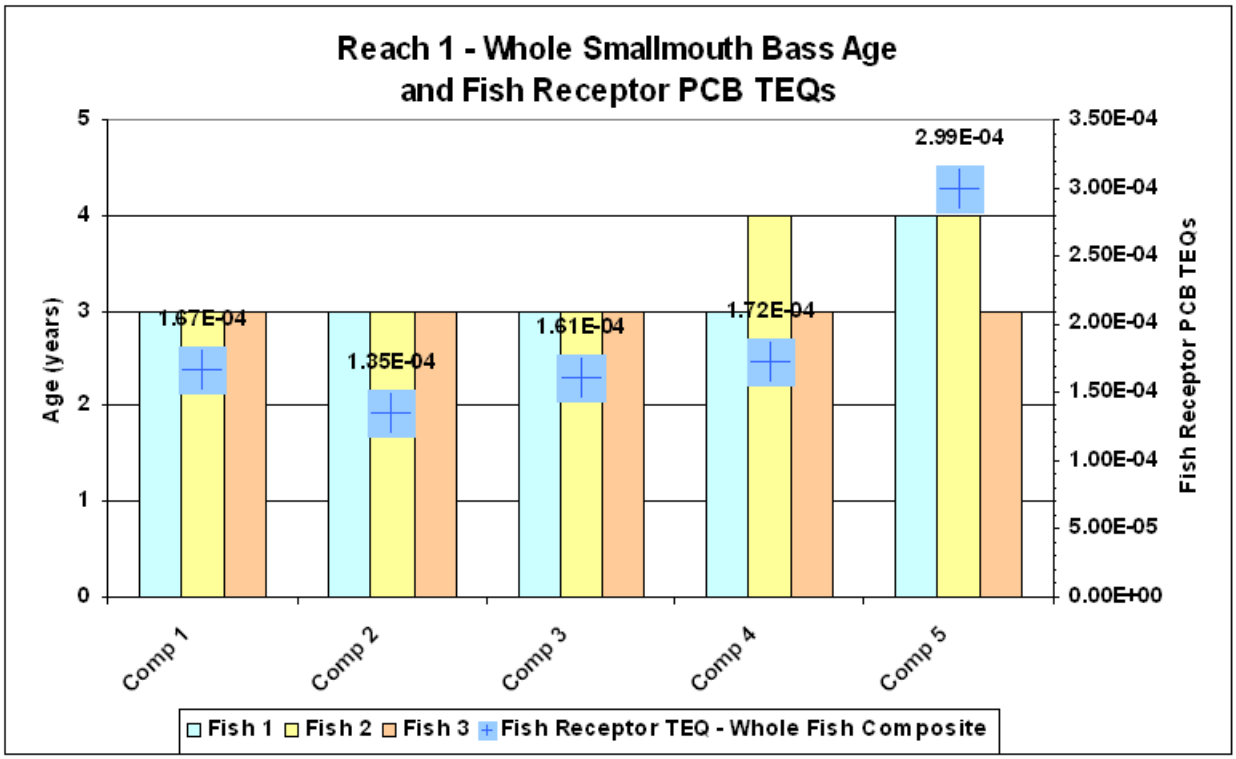

Figure 181. Reach 1 - Whole Smallmouth Bass Age and Piscivorous Fish Receptor PCB TEQs

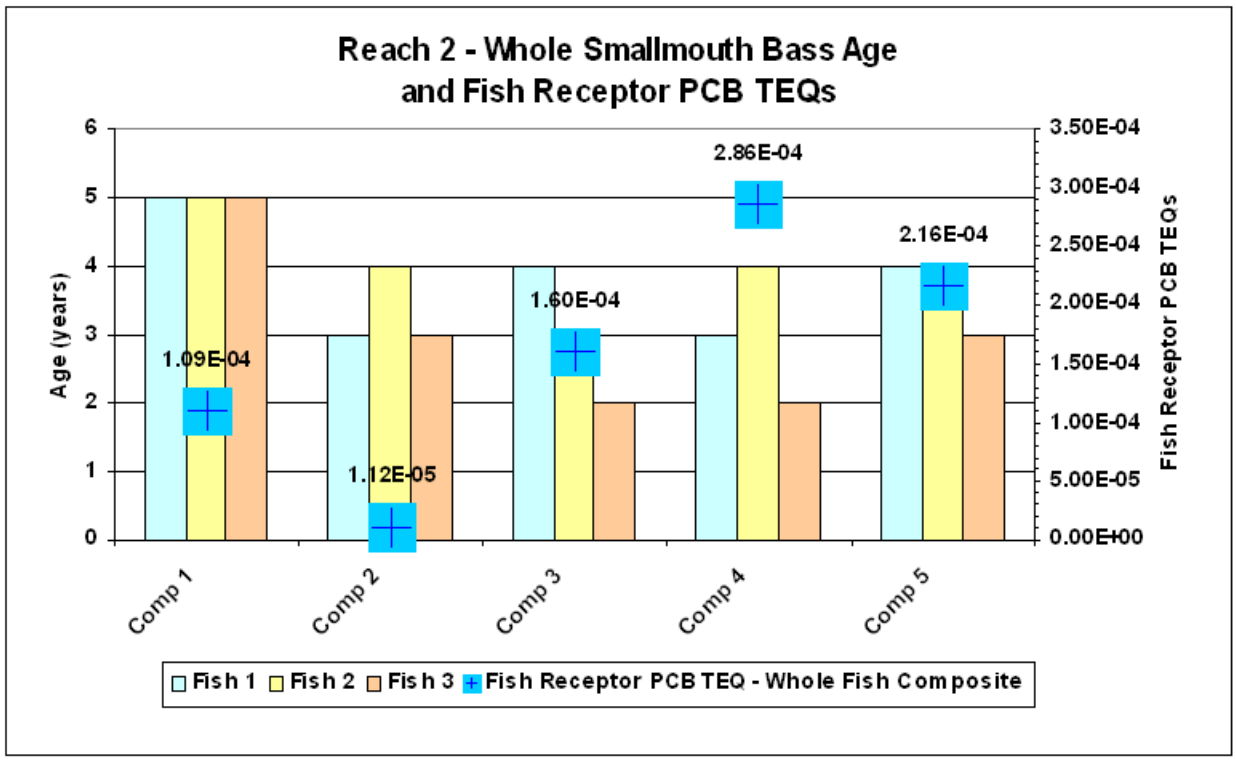

Figure 182. Reach 2 - Whole Smallmouth Bass Age and Piscivorous Fish Receptor PCB TEQs

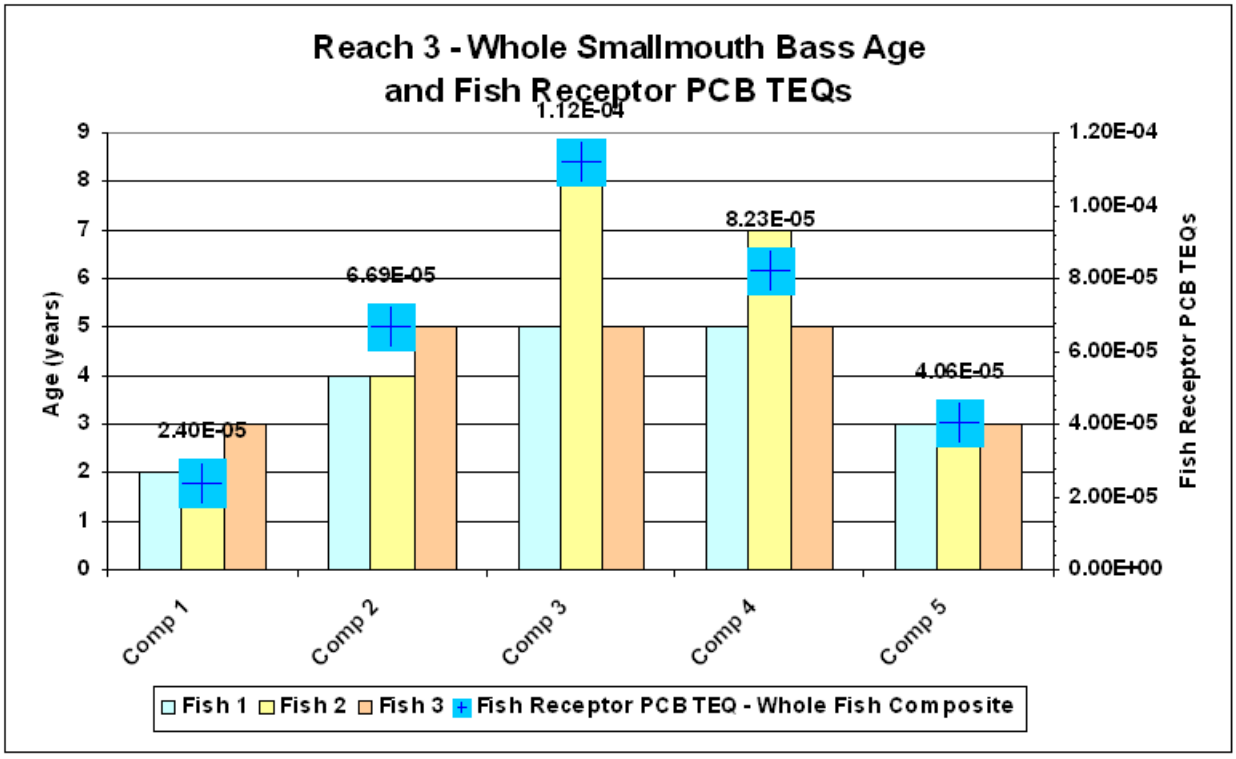

Figure 183. Reach 3 - Whole Smallmouth Bass Age and Piscivorous Fish Receptor PCB TEQs

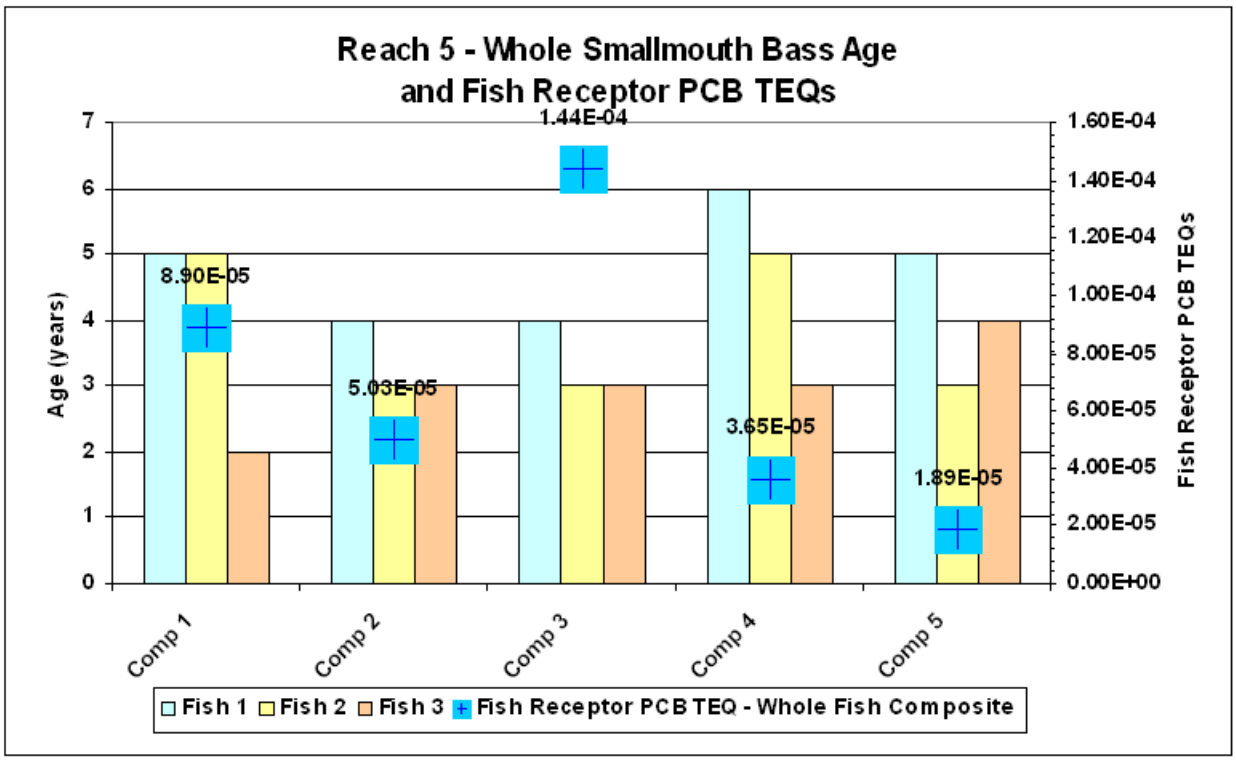

Figure 184. Reach 5 - Whole Smallmouth Bass Age and Piscivorous Fish Receptor PCB TEQs

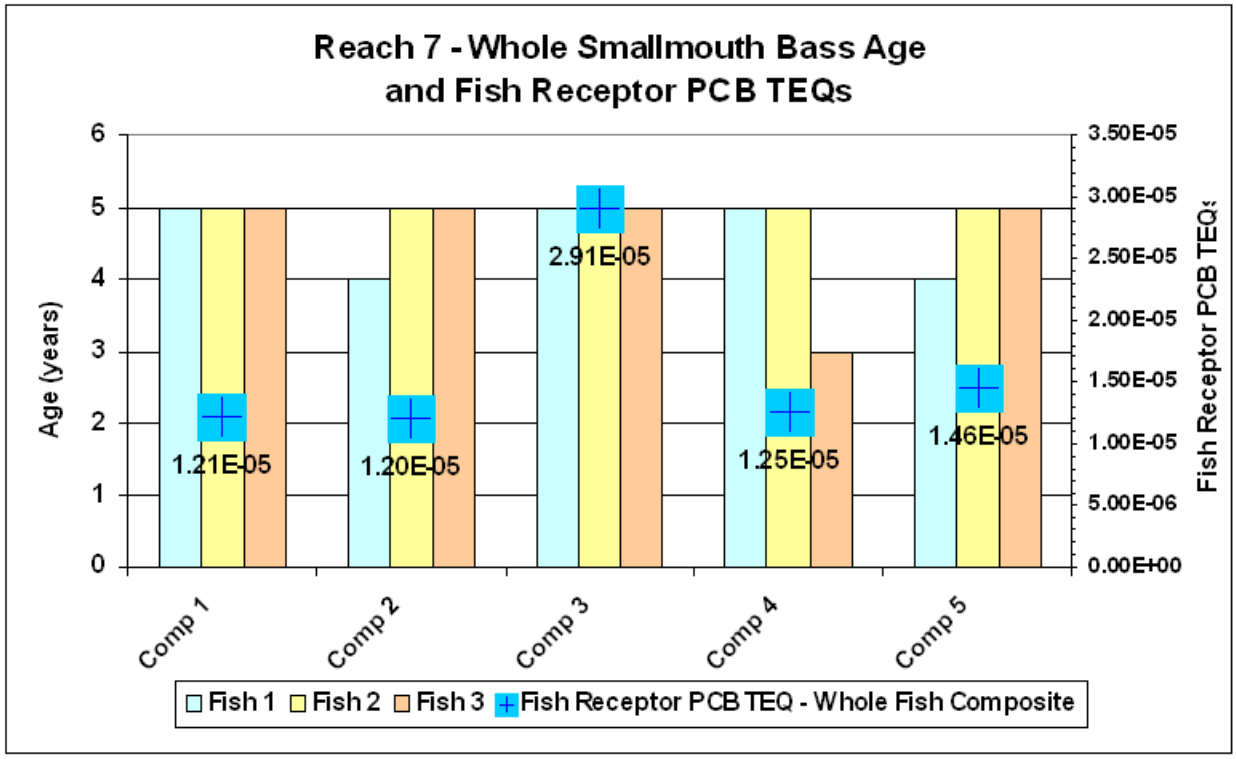

Figure 185. Reach 7 - Whole Smallmouth Bass Age and Piscivorous Fish Receptor PCB TEQs

6.3.3 Bird Receptor Coplanar PCB TEQs and Age

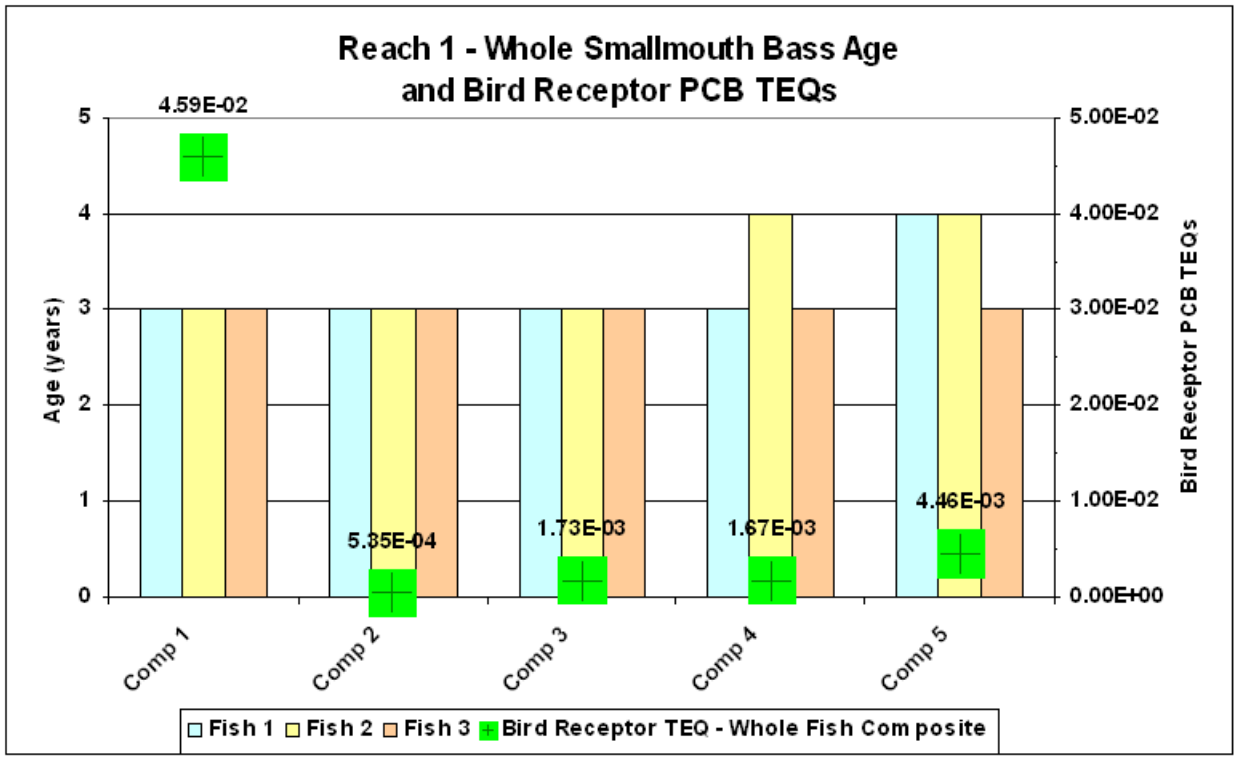

Figure 186. Reach 1 - Whole Smallmouth Bass Age and Piscivorous Bird Receptor PCB TEQs

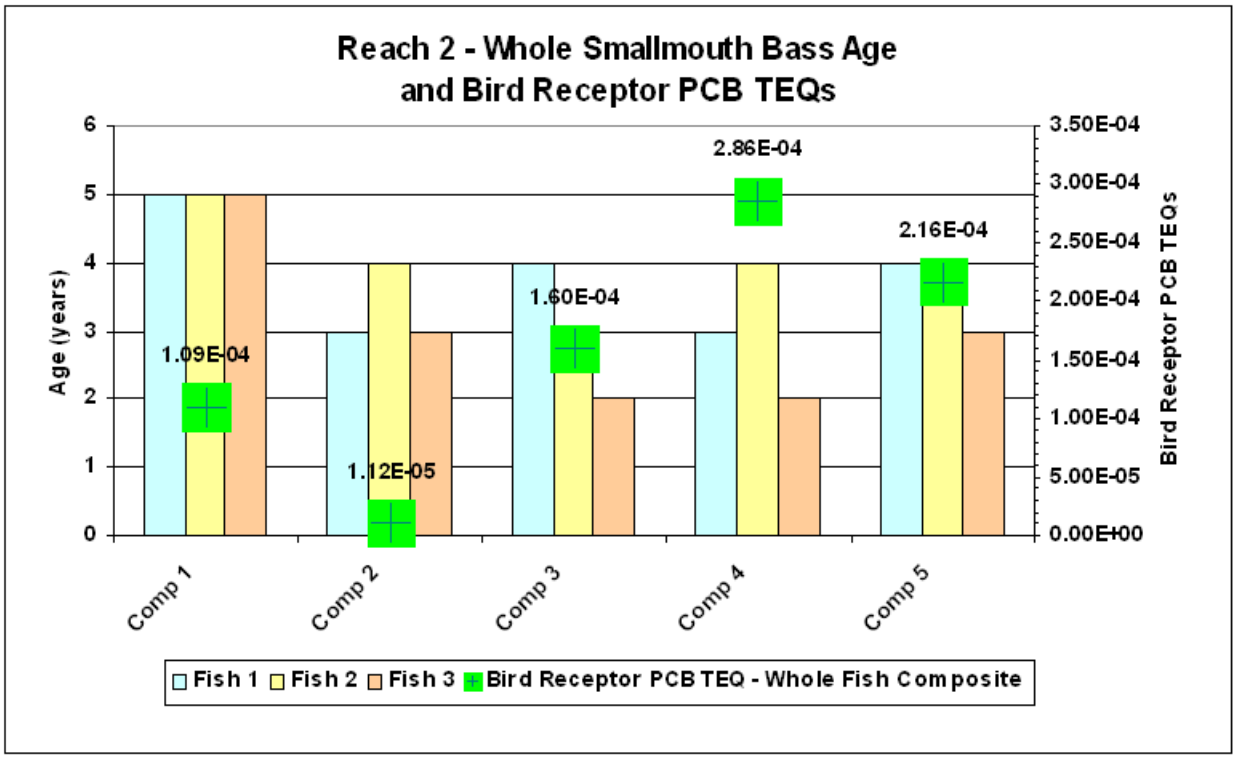

Figure 187. Reach 2 - Whole Smallmouth Bass Age and Piscivorous Bird Receptor PCB TEQs

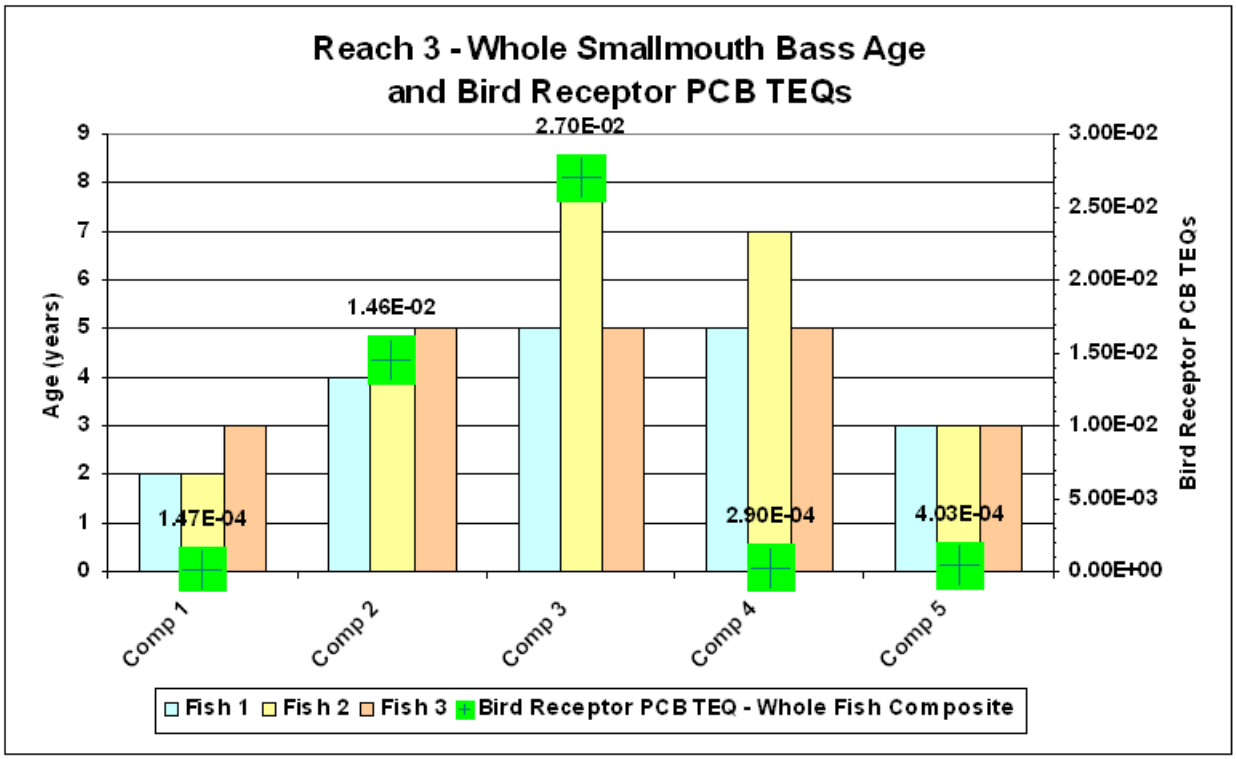

Figure 188. Reach 3 - Whole Smallmouth Bass Age and Piscivorous Bird Receptor PCB TEQs

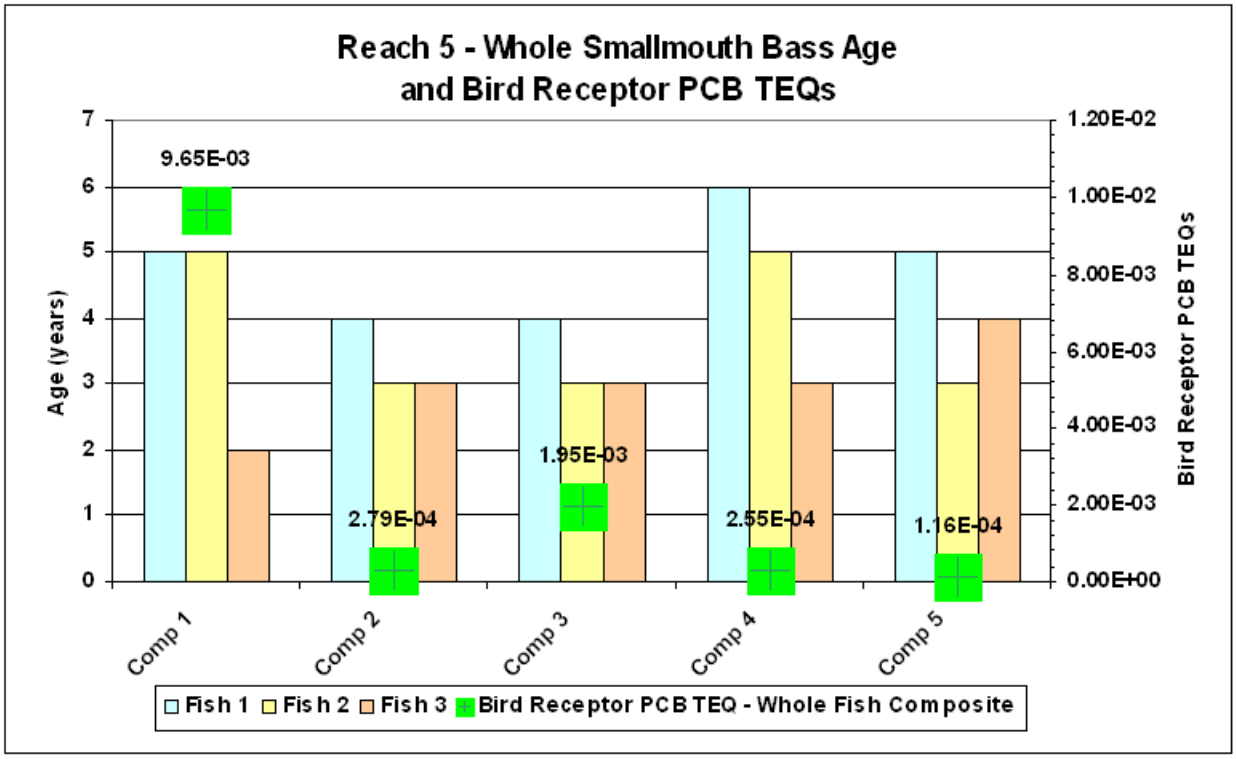

Figure 189. Reach 5 - Whole Smallmouth Bass Age and Piscivorous Bird Receptor PCB TEQs

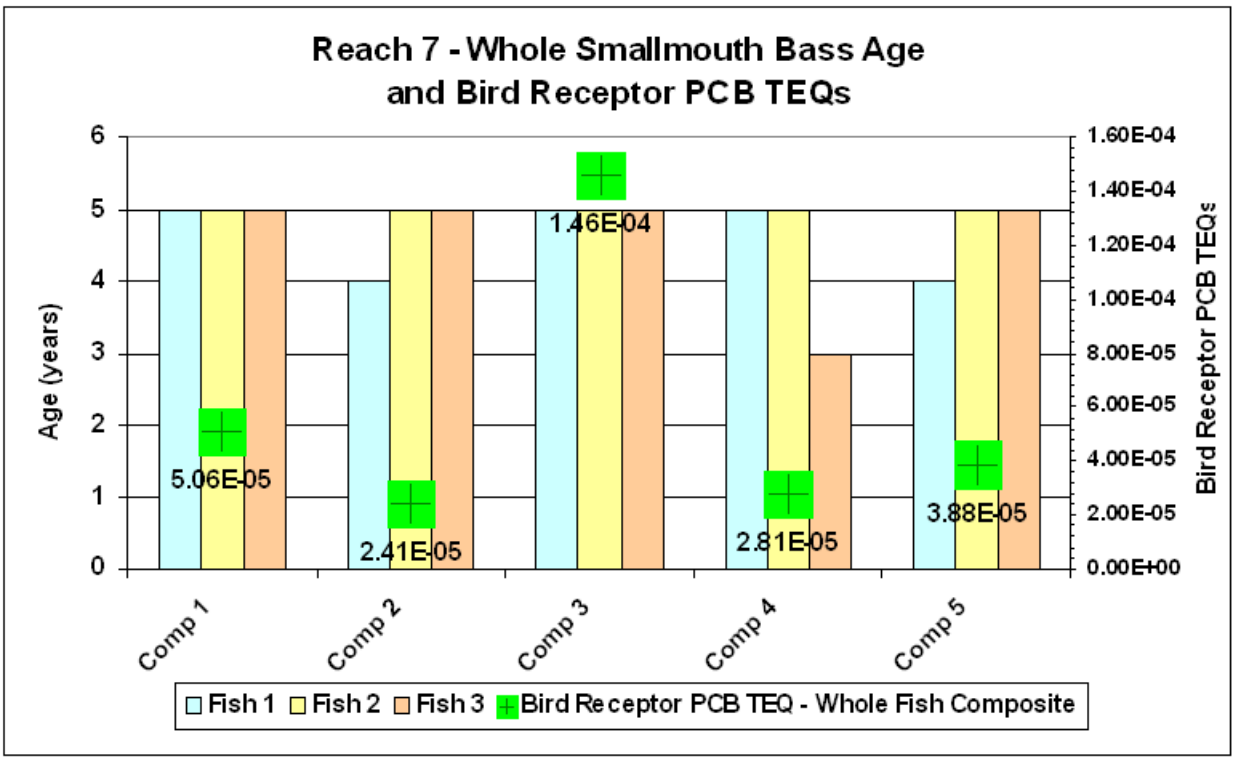

Figure 190. Reach 7 - Whole Smallmouth Bass Age and Piscivorous Bird Receptor PCB TEQs

6.3.4 Summary of PCB TEQs and Whole Smallmouth Bass Age

Although Figures 176-190 show no consistent graphical relationship between smallmouth bass age and human/mammalian, fish or bird receptor coplanar PCB TEQs, a statistically significant negative correlation was observed in all three (Table 58). Age, although a statistically significant factor, clearly only accounts for a portion of the the observed variability in coplanar PCB TEQs for human/mammalian and fish-eating fish and fish-eating bird receptors. Factors affecting individual fish exposure to specific coplanar PCBs, in addition to age, are also important predictors of whole smallmouth bass TEQ burden.